Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

United States
Department of
Agriculture

Research and
Education Committee

March 1991

aS21
A2452

1989 Annual Report on the Food and Agricultural Sciences

From the Secretary of Agriculture to the President and the Congress of the United States

1990 MAY 25 A 1:35

PREFACE

This report was prepared as requested by Congress in the National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1410, as amended (7 U.S.C. 3125). Overall responsibility for development of the report was assigned to the Agricultural Research Service by the Assistant Secretary of Agriculture for Science and Education.

USDA agency representatives who helped prepare this report were James E. Haskell, Agricultural Cooperative Service; Harold S. Ricker, Agricultural Marketing Service; James T. Hall, Agricultural Research Service; Larry D. Mark, Animal and Plant Health Inspection Service; John A. Naegele, Cooperative State Research Service; Verla C. Rape, Economic Research Service; Donald A. West, Extension Service; Steven N. Tanner, Federal Grain Inspection Service; Barbara C. Weber, Forest Service; Alanna J. Moshfegh, Human Nutrition Information Service; Brian W. Norris, National Agricultural Library; James J. Cotter, National Agricultural Statistics Service; Michael L. Young, Office of Budget and Program Analysis; James O. Butcher, Office of International Cooperation and Development; and Hunt B. Ashby, Office of Transportation.

Copies of this report can be obtained from James T. Hall, National Technology Transfer Coordinator, USDA-ARS-OCI, Room 404, Building 005, BARC-West, Beltsville, MD 20705, telephone (301) 344-4045; FAX (301) 344-5060.

CONTENTS

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

FEDERAL, STATE, AND PRIVATE INDUSTRY SUPPORT FOR THE FOOD AND AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURE

The U.S. Department of Agriculture's (USDA's) research and education (R&E) agencies supported food and agriculture research, Extension, and teaching programs funded at approximately $1,481 million in fiscal year (FY) 1989, up 3.4 percent from FY 1988. These programs were centered in the Agricultural Research Service, Cooperative State Research Service, Extension Service, National Agricultural Library, Forest Service, and Economic Research Service. Other agencies having research and education activities include the Agricultural Cooperative Service, Animal and Plant Health Inspection Service, Agricultural Marketing Service, Human Nutrition Information Service, Office of International Cooperation and Development, Office of Transportation, National Agricultural Statistics Service, and Federal Grain Inspection Service. USDA research and education program funding for fiscal year 1990 is estimated to be approximately $1,553.2 million (table 1).

The research and education programs of the Department are complementary and mutually supportive in providing new knowledge, technology, and information on food, agriculture, and forestry issues vital to producers, marketing firms, consumers, and action agencies. The results of these efforts affect the total economy of the United States and hundreds of millions of consumers here and abroad. Including input supply, production, processing, and marketing, the agriculture and forestry sectors account for approximately 15 percent of the gross national product and 16 percent of the civilian employment in the United States. These sectors also provided $18.2 billion in export trade surpluses in 1989. This helped to offset the U.S. trade deficit in other categories. At home, the cost of food to consumers as a share of disposable income continues to decline.

In 1989, estimates are that food required only about 11.7 percent of U.S. consumers' disposable income, down from 13.6 percent in 1979. At the farm level, food costs for U.S. consumers in 1989, as a percentage of disposable income, were only about 3 percent, since 75 percent of the cost of food is due to food marketing costs. In 1989, food marketing cost $320.4 billion, up 6.0 percent from 1988. Labor costs alone for marketing, in 1989, were $146.7 billion compared with $103 billion for food at the U.S. farm level.

USDA research and education programs address national issues in production efficiency, export markets, marketing efficiency, biotechnology, natural resources management and conservation, human and community development, and human nutrition. Research and education programs financed by the Department, encompassing

this complex array of issues, are approximately 2.3 percent of the $66.7 billion obligated for Federal research and development in FY 1990.

Funding for USDA research and education programs has increased in current dollars from $1,143 million in FY 1982 to $1,553.2 million for FY 1990 (table 1 and fig. 1). However, the gain in current dollars for research and education was largely offset by inflation over the period. In constant 1982 dollars, funding was 1.5 percent more in FY 1990 than in FY 1982 (table 3 and fig. 2).

The overall R&E funding, year to year, in constant dollars over the FY 1982-90 period has tended to vary only modestly. USDA funding for research in constant dollars was highest in FY 1990 and next highest in FY 1985. Funding for education in constant dollars declined in five of nine years during the FY 1982-90 period. In constant dollars, funding for education declined 9.1 percent over the period (table 3, table 2, and fig. 2).

Differences in funding were apparent among the R&E agencies. Six agencies operating R&E programs over the FY 1982-90 period had funding increases more than sufficient to cover inflation, and seven did not receive increases large enough to cover inflation (table 3).

Table 1.
U.S. Department of Agriculture: Appropriations for research and education, FY 1982-90

Item	1982	1983	1984	1985	1986[1/]	1987	1988	1989	1990[1/]
				Million Dollars					
RESEARCH									
Agricultural Research Service[2/]	423.2	451.9	471.1	491.4	483.2	511.4	544.2	569.4	593.3
Cooperative State Research Service									
Hatch Act Formula	141.1	147.2	152.3	155.4	148.8	148.8	155.5	155.5	155.1
Cooperative Forestry	12.0	12.4	12.7	13.1	12.4	12.4	17.5	17.5	17.3
1890 Colleges and Tuskegee	21.5	21.8	22.8	22.8	22.3	22.3	23.3	24.3	25.0
Special Research Grants	23.1	27.8	26.5	32.0	30.2	55.1	51.8	61.7	73.1
Competitive Research Grants	16.3	17.0	17.0	46.0	42.3	40.7	42.4	39.7	38.6
Animal Health and Disease	5.8	5.8	5.8	5.8	5.5	5.5	5.5	5.5	5.4
Direct Federal Administration	0.8	0.3	0.6	1.5	1.6	2.9	4.1	6.4	8.2
Forestry Competitive Grants	0.0	0.0	0.0	7.8	6.5	6.0	3.0	0.0	3.9
Total, CSRS[3/]	220.6	232.3	237.7	284.4	269.6	293.7	303.1	310.6	326.6
National Ag. Statistics Svc.	7.0	7.6	8.2	8.4	8.0	3.4	3.6	2.9	2.8
Economic Research Service	39.4	38.9	44.3	46.6	44.1	44.9	48.3	49.6	51.0
Human Nutrition Info. Service	8.5	7.7	6.1	7.5	12.9	7.0	8.6	8.8	9.0
Animal & Plant Health Insp. Svc.	0.0	0.0	0.0	0.0	4.4	4.9	6.6	11.3	13.0
Agricultural Coop. Service	1.7	2.2	2.2	2.9	2.7	2.7	2.7	2.7	3.4
Agricultural Marketing Service	1.5	1.5	1.6	1.6	1.5	1.5	1.6	1.6	1.7
Office of Transportation	1.0	0.8	0.8	1.3	1.1	1.0	1.0	1.0	1.0
Office of Int. Coop. & Dev.	0.7	5.5	5.3	5.4	3.1	4.2	1.5	1.3	2.3
Forest Service	112.1	107.7	109.4	113.8	113.6	126.7	132.5	138.3	150.9
Federal Grain Inspection Service	0.6	0.6	0.7	1.1	0.9	0.8	1.0	0.4	0.3
Total, Research[4/]	816.3	856.7	887.4	964.4	945.1	1002.2	1054.7	1097.9	1155.3
EDUCATION									
Extension Service									
Smith-Lever 3(b&c) Formula	219.4	230.4	235.0	241.5	229.7	235.9	241.6	241.6	242.3
Other Extension Programs	90.0	92.8	93.8	93.9	93.1	96.8	109.0	110.7	118.3
Direct Federal Administration	6.3	5.4	5.5	5.9	5.2	6.3	7.4	9.1	8.7
Total, Extension Service	315.7	328.6	334.3	341.3	328.0	339.0	358.0	361.4	369.3
Cooperative State Research Service									
Morrill-Nelson	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Competitive Fellowship Grants	0.0	0.0	5.0	5.0	2.9	2.9	2.9	2.9	2.8
1890 Colleges Grants	0.0	0.0	0.0	2.0	1.9	1.9	1.9	1.9	1.9
Competitive Challenge Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
1890 Capacity Building Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	5.4
Total, CSRS	2.8	2.8	7.8	9.8	7.6	7.6	7.6	7.6	13.9
National Agricultural Library	8.2	9.1	10.4	11.5	10.8	11.1	12.2	14.3	14.7
Total, Education	326.7	340.5	352.5	362.5	346.4	357.7	377.8	383.3	397.9
TOTAL, Research & Education	1143.0	1197.2	1239.9	1326.9	1291.5	1359.9	1432.5	1481.2	1553.2

1/ Reflects reduction under P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985.

2/ Excludes funds appropriated to ARS for construction, which have been (in millions of dollars): $8.6 ('82), $4.9 ('83), $77.9 ('84), $22.4 ('85), $6.0 ('86), $1.0 ('87), $15.3 ('88), $17.0 ('89), and $12.7 ('90).

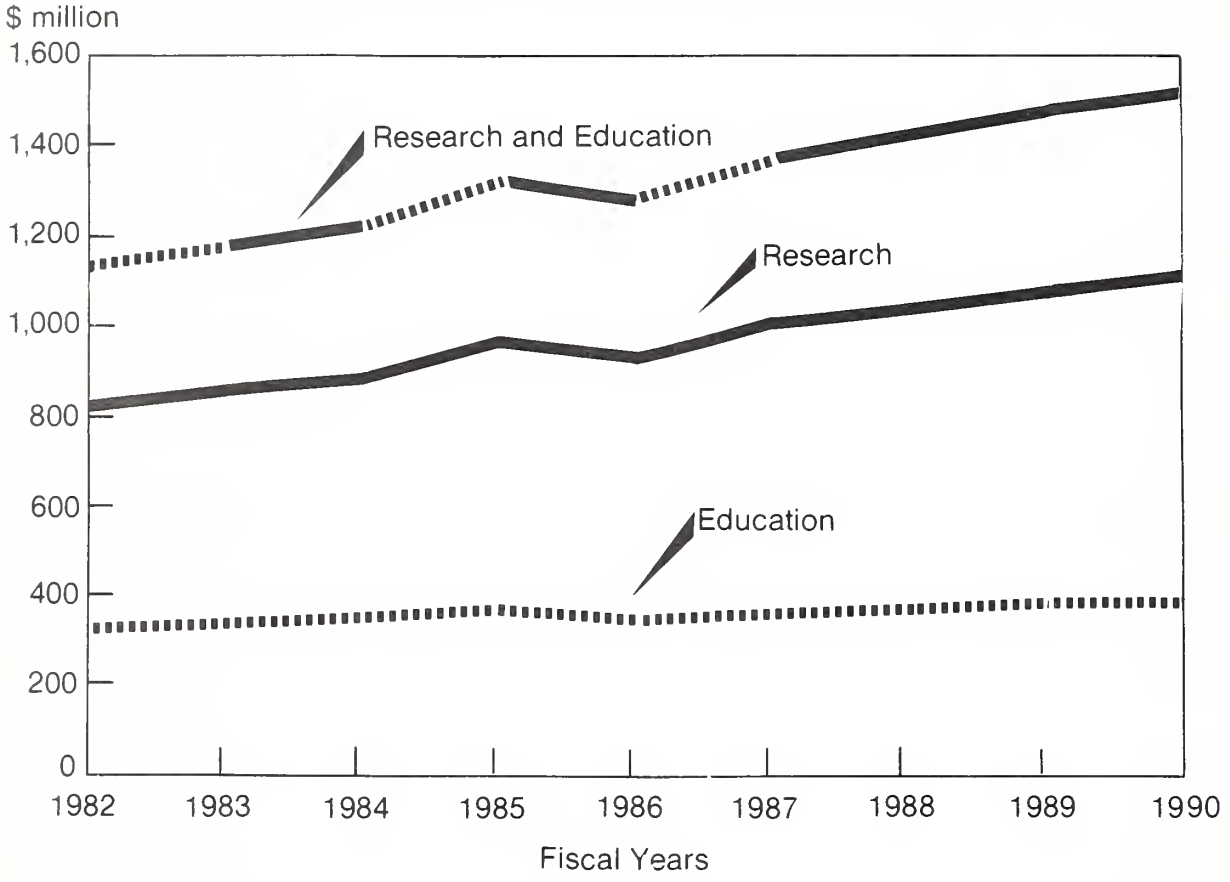
3/ Excludes 1890 Colleges and Tuskegee Research Facilities funding, which has been $10.0 million annually from FY '83 through FY '85 and $9.5 million each in FY '86 and FY '87; and facility funding (in millions of dollars): $66.6 ('87), $42.5 ('88), $23 ('89), and $45.1 ('90).

4/ Excludes 1890 Colleges and Tuskegee Extension Facilities funding of $9.5 million annually from FY '88 through FY '90.

Source: Office of Budget and Program Analysis (OBPA), USDA.

Figure 1

USDA Appropriations for R & D (Current Dollars)



Source — OBPA, USDA

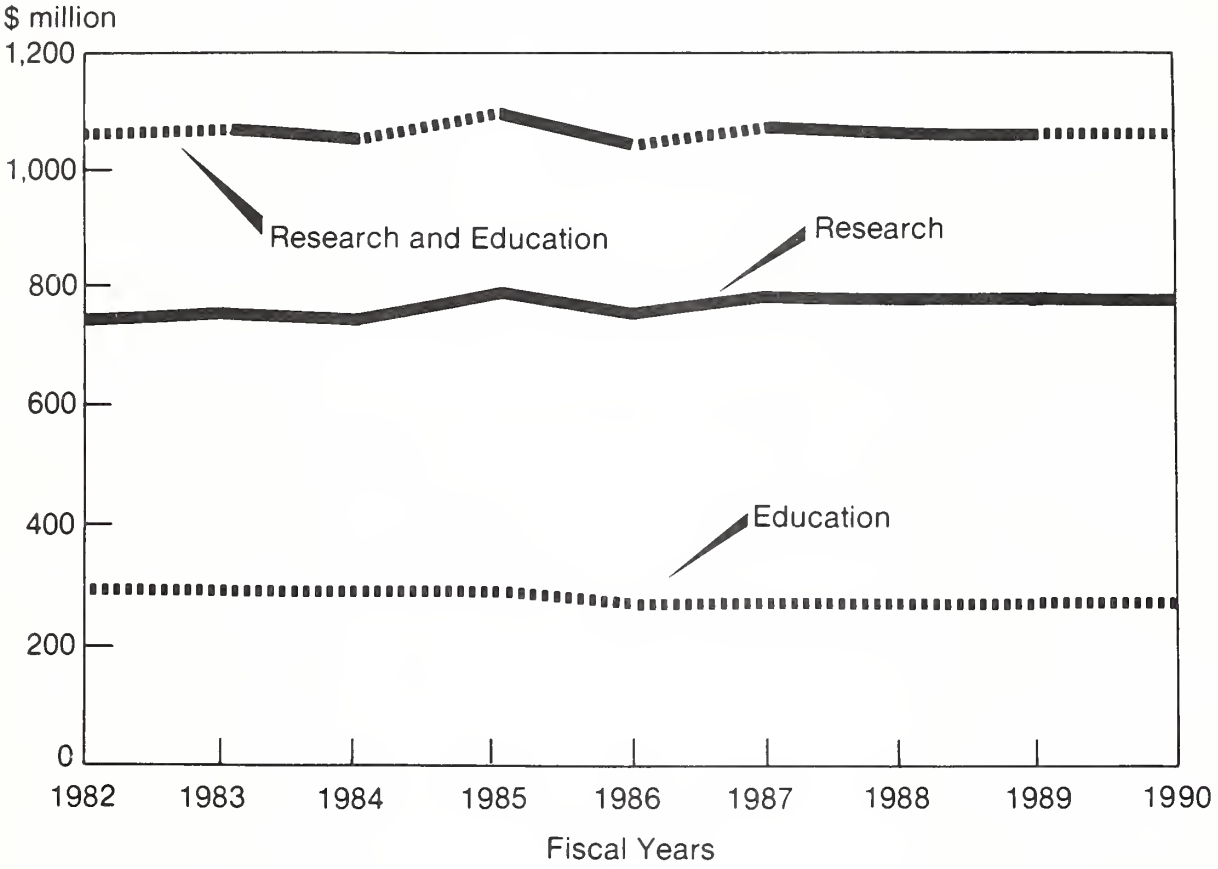
Table 2.
U.S. Department of Agriculture: Appropriations for research and education in constant 1982 dollars, FY 1982-90

Item	1982	1983	1984	1985	1986	1987	1988	1989	1990
Inflation rate		4.0%	4.4%	3.4%	2.0%	3.5%	4.1%	4.3%	4.0%
GNP Deflator for Gov't. Purchases Index: (1982=100)	100.0	104.0	108.6	112.3	114.5	118.5	123.4	128.7	133.9
	Million Dollars								
RESEARCH									
Agricultural Research Service	423.2	434.5	433.8	437.6	422.0	431.6	441.0	442.4	443.1
Cooperative State Research Service									
Hatch Act Formula	141.1	141.5	140.2	138.4	130.0	125.6	126.0	120.8	115.8
Cooperative Forestry	12.0	11.9	11.7	11.7	10.8	10.5	14.2	13.6	12.9
1890 Colleges and Tuskegee	21.5	21.0	21.0	20.3	19.5	18.8	18.9	18.9	18.7
Special Research Grants	23.1	26.7	24.4	28.5	26.4	46.5	42.0	47.9	54.6
Competitive Research Grants	16.3	16.3	15.7	41.0	36.9	34.3	34.4	30.8	28.8
Animal Health and Disease	5.8	5.6	5.3	5.2	4.8	4.6	4.5	4.3	4.0
Direct Federal Administration	0.8	0.3	0.6	1.3	1.4	2.4	3.3	5.0	6.1
Forestry Competitive Grants	0.0	0.0	0.0	6.9	5.7	5.1	2.4	0.0	2.9
Total, CSRS	220.6	223.4	218.9	253.3	235.9	247.8	245.6	241.3	243.8
National Ag. Statistics Svc.	7.0	7.3	7.6	7.5	7.0	2.9	2.9	2.3	2.1
Economic Research Service	39.4	37.4	40.8	41.5	38.5	37.9	39.1	38.5	38.1
Human Nutrition Info. Service	8.5	7.4	5.6	6.7	11.3	5.9	7.0	6.8	6.7
Animal & Plant Health Insp. Svc.	0.0	0.0	0.0	0.0	3.8	4.1	5.3	8.8	9.7
Agricultural Coop. Service	1.7	2.1	2.0	2.6	2.4	2.3	2.2	2.1	2.5
Agricultural Marketing Service	1.5	1.4	1.5	1.4	1.3	1.3	1.3	1.2	1.3
Office of Transportation	1.0	0.8	0.7	1.2	1.0	0.8	0.8	0.8	0.7
Office of Int. Coop. and Dev.	0.7	5.3	4.9	4.8	2.7	3.5	1.2	1.0	1.7
Forest Service	112.1	103.6	100.7	101.3	99.2	106.9	107.4	107.5	112.7
Federal Grain Inspection Service	0.6	0.6	0.6	1.0	0.8	0.7	0.8	0.3	0.2
Total, Research	816.3	823.8	817.1	858.8	825.4	845.7	854.7	853.1	862.8
EDUCATION									
Extension Service									
Smith-Lever 3(b&c) Formula	219.4	221.5	216.4	215.0	200.6	199.1	195.8	187.7	181.0
Other Extension Programs	90.0	89.2	86.4	83.6	81.3	81.7	88.3	86.0	88.3
Direct Federal Admin.	6.3	5.2	5.1	5.3	4.5	5.3	6.0	7.1	6.5
Total, Extension Service	315.7	316.0	307.8	303.9	286.5	286.1	290.1	280.8	275.8
Cooperative State Research Service									
Morrill-Nelson	2.8	2.7	2.6	2.5	2.4	2.4	2.3	2.2	2.1
Competitive Fellowship Grants	0.0	0.0	4.6	4.5	2.5	2.4	2.4	2.3	2.1
1890 Colleges Grants	0.0	0.0	0.0	1.8	1.7	1.6	1.5	1.5	1.4
Competitive Challenge Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
1890 Capacity Building Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Total, CSRS	2.8	2.7	7.2	8.7	6.6	6.4	6.2	5.9	10.4
National Agricultural Library	8.2	8.8	9.6	10.2	9.4	9.4	9.9	11.1	11.0
Total, Education	326.7	327.4	324.6	325.0	302.5	301.9	306.2	297.8	297.0
TOTAL, Research and Education	1143.0	1151.2	1141.7	1181.7	1127.9	1147.6	1160.9	1150.9	1160.0

Source: OBPA, USDA.

Figure 2

USDA Appropriations for R & D (Constant Dollars)



Source — OBPA, USDA

Table 3.
U.S. Department of Agriculture: Percent changes in appropriations for research and education programs, by Agency, from FY 1982 to 1990 in constant 1982 and current dollars.

Agency	Constant 1982 dollars	Current dollars
Research	Percent	Percent
Agricultural Research Service	+4.7	+40.2
Cooperative State Research Service	+10.6	+48.1
National Agricultural Statistics Service	-70.0	-60.0
Economic Research Service	-3.2	+29.4
Human Nutrition Information Service	-21.2	+5.9
Animal and Plant Health Inspection Service[1/]	--	--
Agricultural Ccooperative Service	+47.1	+100.0
Agricultural Marketing Service	-13.3	+13.3
Office of Transportation	-30.0	0.0
Office of International Cooperation and Devel.	+142.9	+228.6
Forest Service	+0.5	+34.6
Federal Grain Inspection Service	-66.7	-50.0
Total, research	+5.7	+41.5
Education		
Extension Service	-12.6	+17.0
Cooperative State Research Service	+271.4	+396.4
National Agricultural Library	+34.1	+79.3
Total, education	-9.1	+21.8
Total, research and education	+1.5	+35.9

[1/] Appropriations were zero in 1982 and increased to $13.0 million by FY'90 in current dollars.

STATE AND COUNTY SUPPORT

State and county support for research and education for the food, fiber, and forestry system at about $1.75 billion in 1989 was slightly higher than that of the Federal contribution of about $1.48 billion. Combined Federal, State, and county funds support approximately 10,000 scientists and 15,000 extension personnel, who are the formulators and extenders of knowledge needed by the Nation's largest industry. Public investment in food and agriculture research and education has consistently provided annual returns of 30 percent or more.

State support for the food and agricultural sciences is provided primarily through the land-grant institutions (1862, 1890, forestry schools, and Tuskegee University) and includes funds for research, extension, and higher education. However, an estimated 50 State-supported, non-land-grant institutions also have agricultural programs. These programs are primarily devoted to higher education.

PRIVATE INDUSTRY RESEARCH AND DEVELOPMENT

The report "A Survey of U.S. Agricultural Research by Private Industry III," published in July 1985 by the Agricultural Research Institute (ARI) of Bethesda, MD, stated that "the best estimate of private industry annual expenditures in agricultural research (is) approximately 2.1 billion dollars." Adjusted for inflation, this estimate would have increased to about $2.5 billion in 1989.

Industry also provided funds to public research organizations to conduct research projects. In 1989 this totaled slightly more than $0.1 billion. Thus total industry support for agricultural research and development in 1989 approximated $2.6 billion.

Based on ARI data, industry overall is apparently devoting approximately 15 percent of its research and development expenditures to basic research, 43.5 percent to applied research, and 41.5 percent to developmental research. However, 62 percent of the companies responding to an ARI survey reported doing no basic research and 36.5 percent reported doing no research of any kind.

Major areas of research conducted by industry, as reported by ARI, are in pesticides, plant breeding, and human food. These three areas accounted for nearly two-thirds of the agricultural research carried on by industry.

FUTURE PRIORITIES FOR THE FOOD AND AGRICULTURAL SCIENCES

Each year the Joint Council on Food and Agricultural Science prepares a report to the Secretary of Agriculture on future priorities for the food and agricultural sciences. This report precedes the submission to Congress of the Department's budget for the fiscal year 2 years in the future. In June 1989, the Joint Council published a report entitled "Fiscal Year 1991 Priorities for Research, Extension, and Higher Education,"[1] which indicated that the Joint Council's priorities for FY 1991 were as follows (in rank order):

1. Improve Water Quality and Quantity
2. Expand Biotechnology and Its Applications
3. Develop Agricultural Production Systems Compatible With the Environment
4. Nurture the Nation's Talent Base in the Food and Agricultural Sciences
5. Improve Understanding of Diet, Human Nutrition, and Health Relationships
6. Enhance Competitiveness of U.S. Agriculture
7. Genetically Improve Economically Important Plants
8. Improve Safety and Quality of Food Products
9. Investigate Potential Effects of Global Climate Changes on Agricultural and Forest Productivity
10. Enhance Control of Agricultural and Forest Pests and Diseases
11. Develop New and Expanded Uses for Agricultural and Forest Products
12. Enhance Rural Economic Development

These priorities, along with input from internal plans and reports from scientific organizations, advisory committees, commodity organizations, and others, form the basis for research and extension planning within the Department. Many of the Joint Council priorities listed above have appeared in prior reports and can be expected to remain high priorities in the coming years. Recent budgets have included increases for water quality, global change, food safety, biotechnology, and other programs in coordination with other USDA and Federal and State agencies. Plans for those programs indicate a continuing commitment for support to solve critical issues facing agricultural producers, processors, and consumers.

[1] Copies of this report can be obtained from:
Joint Council Secretariat
Aerospace Building, Suite 302
U.S. Department of Agriculture
Washington, DC 20250-2200
Telephone: 202-447-8662

AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service (ARS) conducts mission-oriented research to ensure a continuing abundance of high-quality, nutritious, reasonably priced food and other agricultural products to meet domestic and world needs while maintaining environmental quality. ARS uses coordinated, interdisciplinary approaches to conduct basic and applied research pertaining to soil and water conservation, plant sciences, animal sciences, commodity conversion and delivery, human nutrition, and integration of agricultural systems.

Research is conducted at numerous locations in the United States, including Puerto Rico and the Virgin Islands, and in several foreign countries. When appropriate, the research is conducted in cooperation with the State agricultural experiment stations, other State and Federal agencies, and private institutions.

Technology Transfer Awards Initiated

In FY 1989, ARS initiated a program of cash awards to scientists for excellence in technology transfer. Fifteen scientists shared a total of $11,500 in cash awards for their efforts to successfully transfer technology (which they had developed) for practical use by industry firms, consumers, and Government agencies. Technologies transferred by these scientists included a noncaloric, high-fiber flour substitute; a corn-based, highly absorbent polymer; methods to suppress urban pests; improved cotton-ginning techniques; enhanced diagnostic tests for animal disease (leptospirosis); and a model for evaluating the impact of agricultural management alternatives on the potential contamination of groundwater by pesticides.

Patent Applications Increased by 36 Percent

The number of patent applications filed with the Patent and Trademark Office (PTO) by ARS rose from 45 in FY 1988 to 65 in FY 1989, an increase of nearly 36 percent. Patents issued to USDA scientists in FY 1989 were up 25 percent from FY 1988, and patent licenses signed with industry firms increased 13 percent from FY 1988 to FY 1989. Also, revenues from patent licenses in FY 1989 exceeded direct licensing costs for the first time.

Computer Model Developed for Water Quality

A computer model, N-LEAP (Nitrate Leaching and Economic Analysis Package), has been developed to provide rapid, site-specific estimates of the potential leaching of nitrate to groundwater under agricultural crops. The model is based on the contributions of water and nitrogen management specialists from universities, ARS, and other Federal agencies. Site-specific information on farm management practices, crops, soils, climates, and economics is used to assess the economic and water-quality consequences of adjusting nitrogen sources and application rates. N-LEAP was designed to be used by farmers,

farm consultants, Extension agents, and resource planners on any IBM-compatible personal computer.

Alfalfa Reduces Costs and Nitrate Leaching

Research by ARS scientists in Kimberly, ID, has shown that wheat, barley, or corn can be grown successfully with or without tillage and with little or no supplemental nitrogen fertilizer, if the preceding alfalfa crop is killed by tillage or herbicides. By adjusting the cropping sequence to optimize use of the symbiotically fixed nitrogen, operator input costs were reduced by $50 to $80 per acre per year and nitrate leaching was reduced.

New Wheat Lowers Costs by $20 per Acre

Strawbreaker foot rot is the most devastating soilborne wheat disease in the Pacific Northwest. ARS plant scientists in Pullman, WA, have developed the first wheat varieties with resistance to strawbreaker foot rot. Using introduced germplasm from France, these scientists transferred a gene derived from a weedy relative of wheat into a common variety and a club soft white variety of winter wheat. By planting the resistant varieties, farmers can lower their production costs by about $20 per acre and can use less pesticide at the same time.

New Plant Lines Improve Profits and Environment

Over the last 5 years, ARS has introduced 599 new crop varieties and germplasm lines with improved resistance to environmental stress, disease, insect pests, and nematodes and with other improvements in quality. Of these varieties and lines, 483 have improved resistance to diseases, 184 have improved resistance to insects, and 55 have improved resistance to nematodes. Over 83 percent of these introductions are germplasm lines, which are then used by State and private plant breeders to develop improved varieties for specific areas of crop production.

Control of Corn Rootworm With Little Insecticide

ARS scientists located in Brookings, SD, have developed a novel adult-suppression system for the management of populations of corn rootworm. The new technology uses a combination of attractants and feeding stimulants along with a small dose of insecticide in a novel delivery device. It is estimated that use of the device for corn rootworm management will dramatically decrease the use of chemical insecticides on corn crops. Only fields exceeding certain established thresholds will require chemical application. The new system will greatly reduce human exposure to and environmental contamination by chemical pesticides presently used to control this major insect pest. The device contains a bait that attracts only corn rootworms and will have little, if any, effect on beneficial insects.

Mating of Peach Tree Borer Thwarted

Peach tree borers cause an estimated annual loss to the U.S. peach industry of over $20 million. ARS scientists in Byron,

GA, have identified a means to inhibit mating in these insects. Dispensers containing a sex pheromone of the peach tree borer are being used to attract males, which then make futile attempts to mate with the dispensers. Female peach tree borers consequently remain unmated and fail to yield the offspring that can devastate an orchard. Pheromones, unlike chemical pesticides, leave no toxic residues and are cost competitive.

Yields of Drought-Resistant Soybean Are 25 Percent Greater

Soybean yields are reduced by lack of moisture, or drought stress, during the seed-filling period. ARS scientists in Raleigh, NC, have found an exotic Japanese soybean with extraordinary resistance to drought. Two mechanisms give the soybean its drought tolerance: a much deeper root system, and a special chemical adjustment in the leaves that promotes water retention and prevents wilting. Under extreme drought, this soybean yields up to 25 percent more crop than do some of the best yielding varieties grown in the Southeastern United States.

Crops Aided by Biocontrol of Fungal Diseases

New biological control formulations show promise for controlling fungal diseases of a wide variety of crops without harming the environment. Biocontrol of plant diseases with beneficial molds and bacteria is hindered because the end product formulations of beneficial microorganisms are not available. ARS scientists in Beltsville, MD, developed viable, stable, and nonpolluting products that are adaptable to commercial production. These formulations contain beneficial microorganisms that kill several important destructive plant pathogens and prevent diseases on economic crops such as cotton, potato, bean, sugar beet, and ornamentals.

Unique Swine Imported From China

ARS, in cooperation with Iowa State University (ISU) and the University of Illinois (UI), imported 144 pigs of the Meishan, Fengjing, and Ming breeds of swine from the People's Republic of China (PRC). This is the first importation of these breeds, which have been domesticated in China for over 6,000 years. The Chinese breeds produce, on average, 3-4 more pigs per litter than do the average U.S. domestic breeds. It has been estimated that at least 20-25 generations of conventional selection would be required for U.S. swine breeds to increase their litter size to that of the Chinese breeds. These imported swine will be crossed with the U.S. breeds to increase litter size while maintaining the leanness and high quality of U.S. pork. These crosses will be thoroughly evaluated before release to the U.S. swine industry is considered.

Selection of Sex of Farm Animals

The ability to predetermine the sex of offspring would offer the livestock industry increased efficiency, flexibility, and speed in genetic progress in offspring. Studies conducted by ARS scientists in Beltsville, MD, with rabbits and pigs have resulted in the production of live offspring from separate

populations of X- and Y-chromosome-bearing sperm. In studies with rabbits, more than 90 percent of offspring were females after insemination of X-sorted sperm, and more than 80 percent of offspring were males from Y-sorted sperm. Data from pigs are still incomplete but show a 73 percent incidence of males and females from Y- and X-sorted sperm, respectively.

Salmonella in Broilers Reduced at Low Cost

Salmonella contamination of poultry products is an important public health concern. Humans can contract Salmonella infection from eating contaminated meat, resulting in diarrhea, vomiting, and nausea. ARS scientists at the Veterinary Toxicology and Entomology Research Laboratory, College Station, TX, have found that adding 2.5 percent lactose (milk sugar) to the drinking water of 1-day-old chicks sharply reduced the incidence of Salmonella colonization in the chicks. The lactose treatment could cost as little as 2 cents per bird.

Diagnosis of Anaplasmosis in Cattle by a Gene Probe

Anaplasmosis, a disease of cattle, causes deaths, abortions, and weight loss and is estimated to cost the U.S. cattle industry more than $100 million per year. ARS researchers in Pullman, WA, and coworkers at Washington State University and the University of Florida have developed a DNA probe that is revolutionizing anaplasmosis investigations. Until development of the probe, no convenient and economical means existed to identify chronic-carrier cattle and infected ticks. Where anaplasmosis has been established in a herd, the probe is 50-90 percent more effective than conventional tests in identifying carriers. The probe will detect anaplasma in cattle before they are sick and before the organisms appear in blood smears.

Dopamine Antagonist Protects Against Fescue Toxicosis

Tall fescue is an important cool-season grass grown on over 35 million acres in the United States, and most of the plants are infected with an internal fungus. Cattle frequently become ill when they graze infected fescue. Production losses of $1 billion a year from poor weight gain and reduced reproductive efficiency have been projected. Research demonstrated the efficacy of animal treatment with a dopamine antagonist to overcome the effects of toxic fescue. The compound improved steer gain by over 100 percent, with greater improvement at the higher level of fungus infection in the plant. The use of this compound against fescue toxicosis is covered by a patent shared by ARS and the University of Georgia.

Identification of Catfish Disease Made Possible

A mud-dwelling bacterium, Edwardsiella ictaluri, is suspected of causing up to 40 percent of all catfish diseases in the Southeastern United States. Mortality of catfish in an infected pond can reach 50 percent. Fish farmers have traditionally used feed dosed with antibiotics without knowing if their fish are really at risk. ARS scientists in Auburn, AL, have found that a

protein from the bacterium can be mixed with blood from a sample of fish to determine if the fish are infected. The protein may be ready for commercial evaluation in 1990 and may form the basis for a vaccine to protect catfish against Edwardsiella ictaluri infection.

Cell Culture Produces Anticancer Drug

The expanded use of taxol in clinical trials for cancer chemotherapy is limited by the scarce supply of the drug. The Taxus brevifolia tree, used as raw material, is both uncultivated and slow growing. Since organic synthesis of taxol is not yet possible because of its complex structure, a system to grow plant cells in culture to produce taxol would have commercial value. At the Southern Regional Research Center, New Orleans, LA, a novel method has been developed for growing viable Taxus cells in culture for prolonged periods. The National Cancer Institute has responded very positively to the results, and a Cooperative Research and Development Agreement is being established between ARS and a pharmaceutical company to develop the technology.

Retention of Flavor in Cooked Meat

Retention of desirable meat flavor and prevention of flavor deterioration in cooked meats are of significant economic importance to the institutional and convenience food markets. A compound called chitosan, made from chitin (a substance found in crab and shrimp shells), was shown by researchers at the Southern Regional Research Center, New Orleans, LA, to be an excellent scavenger for the trace metal ions that contribute to lipid oxidation and loss of flavor. A taste panel confirmed that meats treated with chitosan retained a higher degree of desirable flavor qualities than did untreated meats. A patent for use of the compound as a food additive has been issued and has elicited more than 100 inquiries from industrial firms about licensing.

Cotton-Farming Profits Improved up to $40 per Bale

Enhancement of cotton quality is hampered by the variability of the trash level and moisture content before processing at the gin. To solve this problem, the ARS Cotton Ginning Laboratory, Stoneville, MS, developed a computerized process control that measures fiber moisture and trash content before, during, and after gin cleaning and drying, and controls the flow of cotton through an optimal equipment sequence. This system can increase farmer profits up to $40 per bale. The system has been installed in a small-scale gin, and field tests in a commercial gin are under way.

Peanut Culture Improved by Use of Expert System

Peanut farmers are facing high production costs, increased health risk because of extensive use of pesticides, tremendous crop losses due to soilborne pests, and very complex problems of irrigation and pest control. Scientists in Dawson, GA, have

developed a computer program known as the Peanut Expert System (PEANUT).

Using PEANUT, a farmer can make production decisions based on research findings rather than on intuition. A farmer using PEANUT on a personal computer is led through a planned strategy of irrigation and pest control. One of the expected benefits is the reduced amount of chemicals required for control of peanut pests and diseases normally occurring in an overirrigated field. The program should cut total water use to 16-20 inches per crop-year and should reduce chemical use by 10-30 percent. Average crop yields should increase by 300-400 pounds per acre per year. Moreover, a higher quality crop could improve profits by about $30 per ton.

A Carbon Dioxide Model of Global Change

Much interest is focusing on global change and the ways in which the activities of humans may be changing the earth's environment. Models have been extensively used to evaluate the potential impact of global change on agricultural productivity. With few exceptions, these models do not take into account the concentration of carbon dioxide (CO_2). A model has been constructed by ARS scientists at Beltsville, MD, that calculates canopy photosynthesis as a function of CO_2 and other important environmental variables. The photosynthesis model is being incorporated into crop models to give more realistic predictions of crop response to future environmental conditions. The model indicates that an increase of CO_2 by 50 percent will increase crop production by 15 percent if no other factor is limiting.

Lowering Dietary Risk Factors for Heart Disease and Stroke

Coronary heart disease (CHD), although declining in the United States, remains the most common cause of death, with over 1.25 million heart attacks occurring annually. Dietary risk factors have been identified that relate to the high incidence of this disease. In adult males, low-fat diets containing lean meats trimmed of separable fat and low-fat milk did not increase the risk factors associated with CHD. Increasing the dietary polyunsaturated fatty acid (linoleic) in place of saturated fatty acids, with total dietary fat kept constant, resulted in more desirable blood clotting times in males. These results, obtained at the ARS Western Human Nutrition Research Center, San Francisco, CA, indicate that ingestion of lean meat and low-fat milk does not increase the risk of heart disease and that an increase in the amount of polyunsaturated fatty acids in the diet may decrease the risk for stroke.

Protein Requirements of Nursing Mothers Studied

Estimated protein requirements of lactating women may be low. A 12-month study of healthy lactating women at the ARS Children's Nutrition Research Center at Baylor College of Medicine, Houston, TX, revealed that both the quantity of milk produced and the concentration of protein in the milk were influenced by

the mother's dietary protein and energy intake as well as her body protein metabolism. The amount of dietary protein intake recommended for lactating women by most health and scientific organizations is 1 gram of protein per kilogram of body weight daily. Lactating women who consumed this amount of protein, despite higher energy intakes, had lower nitrogen balances than did the nonlactating control women. This finding suggests that the current recommended dietary allowance for protein may be insufficient to fully meet the needs of well-nourished lactating women.

Vitamin E Improves Immune Response of Elderly

Older persons generally have a diminished immune response, which leads to more infections as they age. At the ARS Human Nutrition Research Center on Aging at Tufts University, Boston, MA, the effect of daily vitamin E supplementation on several indicators of immune response was measured in 32 healthy subjects over 60 years old. The results showed that immune response was improved. The findings suggest that vitamin E supplementation may improve immune responsiveness in healthy elderly.

COOPERATIVE STATE RESEARCH SERVICE

The mission of the Cooperative State Research Service (CSRS) is to advance science and technology in support of agriculture, forestry, people, and communities, in partnership with the State Agricultural Experiment Station System, colleges, universities, and other research organizations, and in consonance with the Secretary of Agriculture and the intent of Congress. CSRS scientists work with regional and national groups to ensure the quality of science and to set research priorities. The agency administers USDA research funds appropriated by Congress for the States, gives focus to the broad programs of agricultural research and education in the States, and participates in a nationwide system of research planning and coordination. It also supports and encourages efforts aimed at providing the food and agricultural expertise required by the Nation's modern, high-technology, knowledge-based system.

State Cooperators

The programs of CSRS are carried out cooperatively with the following:

- 59 State and Territorial agricultural experiment stations;
- 17 of the 1890 colleges, including Tuskegee University;
- 28 schools of forestry; and
- 28 colleges of veterinary medicine.

Most of these institutions are associated with the land-grant universities. When all publicly supported agricultural research is taken into account, including all research agencies within USDA, two-thirds of the full-time equivalent scientist-years are found in the State Agricultural Experiment Station System. Because of shared responsibilities between research and teaching in the universities, the actual number of scientists is far larger. This provides a wide range of talent capable of addressing most kinds of problems faced by agriculture.

Vaccination System Developed for Hay

Researchers at the South Carolina Agricultural Experiment Station have developed a system that "vaccinates" hay bales against rain damage through the injection of propionic acid. The system attaches to the back of a baler and injects propionic acid into hay bales. The acid is a fungicide that controls the bacteria in hay bales. By killing the bacteria, the acid allows a farmer to bale hay at 25-30 percent moisture instead of waiting for the 20 percent moisture normally recommended for baling. According to the researchers, baling hay at high moisture levels without using the acid treatment allows mold to

develop, which ruins the hay as livestock feed. High moisture content also raises the bale temperature enough to cause burning. In the new system, a switch activates two probe-carrying plates on either side of the chute after hay is baled. Once the probes penetrate the bale, another switch activates the acid spray. Anhydrous ammonia was previously used as the treating chemical, but it was toxic for humans and animals. The change was then made to propionic acid, which is nontoxic but highly corrosive.

New Genetic Engineering Technique Blasts Genes Into Cells

University of Wisconsin researchers have successfully inserted three foreign genes into trees using a new method of gene transfer known as blasting. The new technique involves shooting desired genes into cells at high speeds. Blasting, or biolistics, works on a much wider variety of organisms than do traditional methods of gene transfer. Blasting also allows researchers to produce genetically altered plants more quickly. In genetic engineering, scientists incorporate desired genes from one organism into the cells of another. The goal is to produce plants with desired traits such as resistance to diseases, insects, or herbicides. The researchers are currently using the new technique to incorporate a gene from Bacillus thuringiensis (Bt) into cells of poplar and spruce trees. Bt is a bacterium that provides effective natural control against certain destructive insects. The desired gene is responsible for producing the compound in Bt that kills the insects. Blasting incorporates the Bt gene into tree cells so that the genetically altered plant will develop a natural resistance to insect attacks. Blasting also allows researchers to get a genetically altered sapling in less than 6 months. Traditional gene transfer methods, which involve using a pathogen to carry the desired genes into a plant, require more than a year to produce a genetically altered sapling. The new technique should work on almost any tissue or cell type and can deliver the desired genes to target cells more efficiently than traditional gene transfer techniques.

Automated Procedure for Pesticide Analysis Developed

An automated procedure for analysis of pesticides has been developed at the Connecticut Agricultural Experiment Station and is now in use to detect and quantitate pesticide residues on fruits and vegetables. The new procedure replaces a labor-intensive method that requires 2 days to prepare and test a maximum of four samples. With the use of the automated procedure, up to 10 samples can be prepared and analyzed each day. The equipment operates overnight and produces the results by the next morning. The procedure can test fresh fruits and vegetables for up to 22 organochlorine and organophosphate pesticides.

New Peanut Products Developed

Scientists have discovered two new peanut products that may be useful to people who cannot digest dairy foods. Using milk made from crushed peanuts, food scientists at the Georgia Agricultural Experiment Station have created a liquid coffee whitener and a nondairy whipped topping. Peanut milk is an off-white, almost tasteless liquid made from peanuts washed in bicarbonate of soda. The process bleaches the peanuts and removes some of the "bean" taste. The two products are a combination of peanut milk, corn syrup, coconut oil, and emulsifiers. The milk has already been used in a variety of products, including cheese spreads and flavored drinks. Researchers continue to explore uses of peanut milk, including use as a coffee whitener in powdered form.

Genetic Engineering Yields Viral Insecticide

Researchers at the Texas Agricultural Experiment Station have engineered a moth-killing virus that affects only moths. Under normal conditions, certain genes in a moth produce hormones that regulate the level of water in the insect's body. But infection with the altered virus causes overproduction of these hormones, killing the insect in about a week. The researchers are experimenting with two water-regulating genes. One governs the insect's ability to eliminate water, and the other controls water retention. Depending on the gene, the virus can be used either to dehydrate the insects or to "drown" them. Gene-carrying viruses can be used to attack, in insects, at least two dozen critical physiological processes that are regulated by hormones. Viral insecticides can be formulated into liquids and sprayed on crops, targeting such pests as the cotton bollworm, corn earworm, and tobacco budworm. Commercial production is several years away.

Aquaculture Production and Management Techniques Developed

Scientists at Kentucky State University have developed production and management recommendations specific to Kentucky and provided technical support for individuals interested in aquaculture production. Since 1984, the number of producers in Kentucky has increased by approximately 90-110 percent and production acreage has increased by 400 percent. Also, two processing plants have recently opened. With production increase, secondary jobs in processing, feed production, transport, etc., are generated at a rate of about four indirect jobs for every direct job in production.

Microbial Insecticide Used

Because the use of chemical insecticides involves much controversy, a shift to the use of microbial insecticides has begun. This type of control has several advantages over chemical usage. Entomopathogens, being relatively specific, do not harm beneficial insects and pose no hazard to plants, livestock, wildlife, or humans. Scientists at the University of Maryland-Eastern Shore have isolated six potential microbial insecticides. In bioassays using the corn earworm, larva

mortality caused by these isolates ranged from 44 to 72 percent, and 28 percent of the surviving insects were unable to pupate. All six bacterial isolates are likely candidates for biocontrol. The number of microorganisms isolated, developed, and then commercialized for the safe and effective control of insect pests has been far too small, considering the advantages of their use in agriculture. This research avenue may not only identify the organisms for use but also result in finding safe sources of biodegradable compounds that can be used as pesticides.

Horn Fly Device Being Developed

Clemson University scientists are investigating a unique ear device for livestock, which may control horn flies better than the ear tags now available. The horn fly is bothersome to cattle from May to October and causes a big loss in revenue for livestock breeders. With perhaps as many as 1,000 horn flies annoying each animal, the cattle spend more time repelling insects than eating and therefore gain less weight. Depending on the severity of the horn fly problem, a producer can lose an estimated $5.80 per head for calves and $14.25 per head for stocker cattle. Since the late 1970's, the primary method of control has been ear tags injected with insecticide so that the insecticide is incorporated into the plastic. But studies show that a horn fly's exposure to these ear tags builds the fly's resistance to the insecticide. So researchers are developing a device that will discharge a lethal dose of insecticide at a more controlled rate. This new tag has a reservoir (or well) inside it, which holds the insecticide. The insecticide is then dispensed through a rechargeable wicking system, similar to the system in an oil lamp. The entire device is clipped onto the cow's ear. Although the tag is still in development, the scientists are close to a marketable alternative to the impregnated ear tags currently used on cattle.

Program Results for Low-Input Sustainable Agriculture

Now in its third year, the research and education program for low-input sustainable agriculture (LISA) supports or has supported 78 projects. These projects include studies to determine the feasibility and economic effects of (1) reducing the dependence of farmers on purchased chemicals and other inputs and (2) relying more on skilled management, farm resources, greater use of crop rotations, animal and green manures, conservation practices, biological pest controls, and the like. Projects approved for funding by administrative councils in each of four U.S. regions range from studies of the effects of reducing the need for purchased inputs in apple production, to research on LISA methods of producing everything from corn and soybeans to fruits and vegetables. Other projects focus on developing educational materials for farmers. Program results so far include (1) successful formation of new teams of farmers, representatives of private organizations, and university on food science cosponsored by Campbell Soup, Inc., which reached millions of students in kindergarten through grade 12 across the United States.

and USDA professionals to identify LISA research and education needs and to review and approve project proposals; (2) the initiation and conduct of projects expected to boost the interest and involvement of USDA-land grant university professionals in such work; and (3) tentative study results to be compiled, interpreted, and reported in the spring or early summer of 1990.

Computerized Information System Continues

A unique computerized information system known as the Food and Agricultural Sciences Education Information System (FAEIS) continues to be used nationwide. FAEIS provides direct online access to a comprehensive array of current and historical data that are essential to the planning and evaluation of higher education. The data concern enrollments, degrees conferred, student support, placement of graduates, employment opportunities for graduates, and faculty information. This system is the only one of its kind in the Nation.

Development of Scientific and Professional Expertise Is Nurtured

Since 1984, the National Needs Graduate Fellowships Grants Program has contributed significantly toward reducing the serious erosion of our national expertise in the food and agriculture sciences. The average graduate-record examination score of the 476 fellows supported by the program is more than 300 points higher than the average score of all graduate students in agriculture. For the fifth consecutive year, strengthening grants have been provided to the 1890 land-grant institutions and Tuskegee University to enhance their curriculum, faculty, instrumentation, and recruitment of outstanding students. Other high-priority national initiatives to improve the infrastructure of the Nation's higher educational system for food and agricultural sciences included support for the following: (1) A national report, entitled "Educating for a Global Perspective," on internationalizing the agricultural curricula for 2005 to better prepare graduates to function in a global economy; (2) Project 2000, a national initiative directed by the American Home Economics Association to recruit, retain, and graduate minority students in college and university programs in home economics; (3) a science notebook, entitled "Student Research Projects in Food Science, Food Technology, and Nutrition," developed at Ohio State University and distributed nationally to encourage the active involvement of high school students in agriscience; (4) Project INTERACT, which focuses on needed curricula revisions in the Nation's colleges of agriculture as recommended by outstanding professionals from industry, government, and academia; (5) a national conference on "Educating Agribusiness Leaders for Global Competition," which provided a forum for distinguished educators, business leaders, and public officials to discuss recommendations for master's degree programs, faculty development, and continuing education programs in agribusiness; and (6) a national live teleconference

NATIONAL AGRICULTURAL STATISTICS SERVICE

The National Agricultural Statistics Service (NASS) conducts research to improve the statistical methods and techniques used to produce agricultural statistics. This research is done in support of the NASS long-range program for improving the accuracy of crop and livestock estimates at minimum cost and is directed toward better sampling, yield forecasting, survey techniques, and quality assurance procedures. Some highlights of research accomplished in FY 1989 follow.

Research on Interactive Data Editing

Research on interactive data editing is being conducted on several surveys. Data are edited interactively during the survey period either in parallel with or before the normal batch edit. Blaise, a computer software system from the Netherlands Central Bureau of Statistics, is being used for the trials.

Laptop Computers Assist in Survey Interviews and Data Collection

Research is continuing on the technique of developing and evaluating data collected from personal interviews using laptop computers. By means of laptop computers and personal interviews, data have been collected for an Agricultural Survey, including livestock prices. This research also involves the use of Blaise software. Applications using smaller computers, some without keyboards, will be explored.

Computer Assists Stratification of Area Frames

NASS is involved in a cooperative effort with the National Aeronautics and Space Administration (NASA) to develop area sampling frames by use of digital inputs. The project with NASA extends over 3 years (FY 1989-1991). NASA provides software support through the Ecosystem Science and Technology Branch at Ames Research Center, Moffett Field, CA. This project explores the use of digital satellite data and digital line-graph data in the development of area frames. This system allows the operator to delineate areas of homogeneous land parcels (called primary sampling units) onscreen and thus eliminate use of paper-based material, transfer of boundaries from photography to the map base, and the digitization process (for measuring the area). This system improves the ability to use previously classified satellite data as an aid in the stratification process. Three counties in Missouri were stratified in phase 1, and 20 counties in Michigan were stratified in phase 2. Significant productivity gains will be realized with the new system.

Objective Yield Research and Analysis

Panel aspects of the objective yield forecasts were investigated by the use of panel models of month-to-month changes to assess measurement errors. These procedures allow quantitation of the reliability of the various measurements made for use in the forecasting models. Some measurements, such as length of kernel row, were shown to need improvements in reliability. The results

support the need for the research being conducted on measurement of corn surface area and volume. This research shows that corn yield forecasting models can be improved when measurements of corn ear surface area and volume are added to the operational survey program.

A study to determine the usefulness of spatial statistical methods for yield surveys was completed. The potential for improved survey design and error detection was shown. The accuracy of several survey indications of monthly corn yield and also composite forecasts for 10 major corn States were examined. Two of the composite forecasts performed favorably and were recommended for review by the Agricultural Statistics Board.

Reinterview Research on the Agricultural Survey

Reinterview research continued in six States for the December 1989 Agricultural Survey. This research is aimed at expanding procedures for statistical quality assurance. Reinterviews allowed measures to be made of variance and bias in responses and generally helped to identify sources of error in the survey. This work provided important information to the Agricultural Survey Quality Team, which is charged with developing a formal quality-control and management system for the Agricultural Surveys.

Research was completed on the proper use of multivariate hypothesis testing with data from complex studies. The research, originally started for objective yield testing, was needed for the reinterview testings. Several alternatives that depend on design conditions were identified and are more appropriate than the procedures used previously. A computer program to compute the tests was written.

Research on the Farm Cost and Return Survey

The cooperative agreement on the Farm Cost and Return Survey (FCRS) with the University of Georgia is almost completed. This research will permit several types of multivariate statistical analyses over the next year. In addition, research was initiated to take a preliminary look at item nonresponse on the FCRS. Better methods for editing, data imputation, and questionnaire design should result from synthesis of these two research efforts. Results show that nearly 75 percent of farm operators keep organized financial records and that sophisticated practices, such as the use of computers or record-keeping services, are more common for large farms (although still not very common across the board). In addition, data were collected for evaluation of the use of organized farm-record-keeping systems in FCRS in order to enhance the quality of the data and also ease the respondent's burden. Results have provided a foundation for possible reconsideration of the FCRS survey design and data collection methods.

Robust Estimation Increases Accuracy of Survey Indications

Outlier (highly influential) observations occur in NASS survey data, and intermittent outlier effects can greatly impact survey indications. Indications are difficult to interpret at both the State and national levels. Cooperative work with statisticians at Oregon State University explored different robust estimation techniques that are designed to reduce the impact of outlier observations. Preliminary results indicate that more accurate and precise survey indications are possible by the use of these techniques.

Estimation of Crop Acreage

Analysis has indicated significant differences between two major indications of crop acreage from NASS surveys conducted on June 1, 1989. The first indication is based on data collected during a personal interview with the farm operator when maps of sampled land areas were used. The second indication is based on data on total farm crop acreage generally collected by telephone. A reinterview study was planned to investigate the differences between these two survey indications in Ohio and Indiana.

Edits Developed for Livestock Slaughter

Longitudinal time-series edits were developed from previous-year data for each firm to produce its unique edit limits. Rate of kill, patterns of kill, types of animals slaughtered, and average weight appropriate to a firm are a few of the specialized edits. The new edit system was implemented in FY 1989.

Time Series Modeling of Prices

Time series models were generated and evaluated for the Minnesota-Wisconsin (MW) Milk Price and for the entire month Prices Received by Farmers for 39 different State/Commodity combinations. The time series approach was implemented to generate forecasts of milk price and milk fat percent, which are used to provide an improved indication for the MW Milk Price. Research is continuing for Prices Received by Farmers.

Research to Develop Methodology for Using Satellite Data in Crop Estimation

Remote sensing research in FY 1989 centered on comparison of U.S. LANDSAT Thematic Mapper data to French SPOT Multispectral Scanner data for use in acreage estimation of major crops. Data sets containing similar acquisition-date coverage for both sensors were analyzed in Iowa (corn, soybeans), Arkansas (multitemporal: rice, cotton), and Michigan (dry beans, soybeans). Statistical analysis showed the LANDSAT Thematic Mapper to be significantly better, agreeing with the results from an earlier study on winter wheat. In the early 1990's, information gained from this research will be applied to entire State and region estimation for rice, cotton, and soybeans in the Delta region.

New algorithms for the clustering and classification of remotely sensed data were also analyzed in FY 1989.
Changes to the PEDITOR software system supported the above analyses. A significant new development in this system, called PCSHIFT, was implemented. PCSHIFT allows video manipulation of remotely sensed and ground data and eliminates the need for plotters or special printers in our procedures. During FY 1989 the PEDITOR system move from mainframes to the PC environment was completed. The above-mentioned analyses were accomplished on personal computers at substantial cost savings.

ECONOMIC RESEARCH SERVICE

The Economic Research Service (ERS) was established in 1961 principally under the authority of the Agricultural Marketing Act of 1946 (7 U.S.C. 1621-1627). The mission of ERS is to provide economic and other social science information and analysis for improving the performance of agriculture and rural America.

ERS produces such information as a service to the general public and to help Congress and the Administration develop, administer, and evaluate agricultural and rural policies and programs. The wide range of topics covered by ERS includes the following:

- U.S. and world agricultural production and demand for production resources, agricultural commodities, and food and fiber products.
- Costs of and returns to agricultural production and marketing.
- Economic performance of U.S. agricultural production and marketing.
- Effects of Government policies and programs on farmers, rural residents and communities, natural resources, and the public.
- Organization and institutions of the U.S. and world agricultural production and marketing systems, natural resources, and rural communities.

ERS-produced information is made available to the public through (1) research monographs, situation and outlook reports, and data products in electronic media, professional and trade journals, magazines, and newspapers; (2) radio and television; and (3) frequent participation of ERS staff members in various public forums. Journals and magazines include the following, published by ERS: The Journal of Agricultural Economics Research, Agricultural Outlook, Farmline, National Food Review, and Rural Development Perspectives.

Trade Benefits Analyzed

ERS analysts have determined that multilateral trade liberalization, such as might come from the current negotiations under the General Agreement on Tariffs and Trade (GATT), should benefit most economic sectors in all countries. Commodity prices would probably rise, farmers could produce greater quantities, and taxpayers would spend less to support farm sectors.

Alternatives for Crop Insurance Analyzed

ERS economists have determined that a compulsory, free crop insurance program would cost less to administer than the current USDA-administered Federal Crop Insurance Corporation. Such a program, however, would probably be unpopular with many farmers.

Foreign Trade Prospects Seen Promising

ERS studies of several foreign markets suggest that recent events bode well for future U.S. agricultural exports. For example, Japanese diets are including more Western foods, and increased national income in Thailand should increase the demand for livestock products, oilseeds, and oilseed products in that country.

Federal Farm Benefits Seen Concentrated

Half of all USDA income-support payments went to about 127,000 farms that earn more than $40,000 a year, including direct Government payments. Elimination of those payments would hurt farms that specialize in program crops. However, the loss of these payments would not hurt the farms that produce nonprogram crops whose prices are protected by tariffs or supported by other Government programs.

Farm Supports Studied

A recent ERS study found that agricultural support policies in seven industrial countries encouraged inefficient use of resources. These policies also transferred incomes from the nonfarm sector to the farm sector and from consumers and taxpayers to agricultural producers. In 1986, the cost to support the agricultural sectors of these countries was $135 billion, but farmers received only $95 billion.

1987 Law Strengthened Farm Credit

The Agricultural Credit Act of 1987 restructured the Farm Credit System (FCS) and created the Federal Agricultural Mortgage Corporation ("Farmer Mac"). ERS research showed that FCS became stronger in 1987 but that Farmer Mac has had little effect on agricultural lending.

Foreign Debts Hurt U.S. Farmers

ERS studies showed that many developing countries are importing less from the U.S. farm sector as they struggle to repay their massive international debt. These lower sales occur despite short-term export subsidies and credit programs. Reduced imports by these countries reflect the slower economic growth of their domestic economies.

Alternative Pest Control Seen Costly

ERS analysts found that reducing U.S. agriculture's use of pesticides, through either bans of chemicals or use of alternative production strategies, tends to raise costs throughout the marketing chain. The analysts concluded that higher production costs and reduced yields lead to higher consumer prices.

Crop Rotation Widely Used

ERS analysts found that, in 1986-88, U.S. farmers grew different crops from year to year more often than previously thought. For 1986-88, corn was grown consecutively on only 26 percent of the total land, winter wheat on 20 percent, soybeans on 15 percent, and rice on 18 percent. However, cotton was grown consecutively on 57 percent of total land.

AGRICULTURAL COOPERATIVE SERVICE

The Agricultural Cooperative Service (ACS) provides research, technical assistance, and information and education for the Nation's 5,109 farmer-owned cooperative businesses. The agency is the information source within Government for issues of policy, legislation, or regulation concerning farmer cooperatives.

Cooperative Model Rated Best by Rural Development Task Force

The cooperative model has been extremely successful in rural areas and is valid for expanded application to rural development. In a Senate-directed report to Congress, an ACS task force stated that cooperatives are pillars supporting much of the economic base in rural America. Cooperatives are ideal for dealing with the principal disadvantages of rural communities, namely low population densities, smaller markets, and higher service costs. Although cooperatives generally have low visibility, they are already helping to meet many rural development needs. Among these are rural social service needs such as health services, insurance, child care, and housing. Cooperatives are also involved in financial services, telecommunications, electrical power, and water and sewer systems. Cooperatives could be used even more for locating processing or value-added plants in rural areas, providing technical assistance, broadening financial assistance, and serving as a community catalyst for cooperative education and government support systems.

Cooperatives Show Healthy Net Income Gain

The net income of farmer cooperatives was nearly $1,686 million in FY 1988, a 13.4-percent increase from the $1,486 million showing in 1987. The $1,686 million includes intercooperative dividends and refunds of $179 million, an increase of 184 percent from $63 million in 1987. Total net business volume, excluding intercooperative business, handled by cooperatives totaled $66.3 billion, up 10.3 percent from $60.2 billion in 1987. Combined assets of farmer cooperatives rose 5.6 percent to $29.2 billion, compared with $27.6 billion the previous year. The number of cooperatives fell from 5,109 to 4,939.

Top 100 Cooperatives Improve Earnings

Performance of the Nation's 100 largest farmer-owned cooperatives in FY 1988 indicated success in meeting agricultural challenges during the 1980's. Total revenue of the 100 cooperatives in FY 1988 rose nearly 11 percent to $46.6 billion, compared with FY 1987 net margins of $42 billion. Margins before losses were up 22 percent, $150 million higher than FY 1987 figures. However, eight cooperatives (two more than in FY 1987) reported significant losses, limiting FY 1988 net margins (after losses) to a 10.3-percent gain, from $653.6 million to nearly $721 million.

Research on Cooperative Theory Increases

Recognizing that existing theories of agricultural cooperation failed to address many of the problems facing farmers today, agricultural economists are renewing research in this field. Challenges facing the cooperatives include the need to compete with large, often conglomerate, investor-owned firms. The recent theoretical research reaffirms that there are often valid justifications for public policies to support cooperatives, particularly because of their effects on competition in highly concentrated markets and their potential to improve market concentration.

Alternatives for Distributing Cooperative Income

Nonqualified written notices of allocation and per-unit retain certificates offer alternative means for distributing cooperative earnings and allocating patron equity that may have advantages over the methods used by most farmer cooperatives. An indepth report by ACS shows that nonqualified written notices can be used to delay patron taxes and income and to avoid negative cash flows due to tax.

Two ACS Reports on Cooperative Use Are Completed

Two studies describing some major characteristics of farmer members of marketing and farm supply cooperatives were completed. One study involved commercial farm operators, and the other involved all farmer members and the use of these cooperatives. Among the findings is that the percentage of farmers involved with cooperatives increased with increasing farm size. Nearly 80 percent of operators of farms having annual sales of over $100,000 were members of or used cooperatives.

Two Reports Focus on Vegetable Cooperatives

Two reports dealing with fresh vegetable cooperatives were produced. The first involves small-scale fresh-vegetable marketing cooperatives, which are gaining importance as farmers turn to alternative crops for new sources of farm income. The other report concerns the role of fresh-vegetable cooperatives in the overall vegetable market.

Profiles of Cooperatives in Grain and Animal Health Products

Studies of cooperatives that handle grain and cooperatives that market animal health products were completed during FY 1989. The grain report compares information on local cooperatives that are first handlers and have $5 million or more in sales. The report on animal health products uses case studies to identify successful retailing programs.

ACS Works on Nearly 100 Technical Assistance Programs

ACS staff members participated in 97 formal technical assistance programs involving 119 cooperatives in FY 1989. Projects involved 46 existing dairy, fishery, grain, service, livestock, and farm supply cooperatives. Fifty-one projects involved emerging and developing cooperatives representing more than 3,000 producers of fruits, vegetables, peanuts, Christmas trees, hay, grain, and crafts.

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

The Animal and Plant Health Inspection Service (APHIS) conducts research and methods development on its Animal Damage Control (ADC) program through its Denver Wildlife Research Center (DWRC) at Denver, CO. The research is aimed at developing new knowledge necessary to combat vertebrate pests that destroy America's agricultural production. Knowledge and tools resulting from this research are used to reduce wildlife conflicts with agriculture. DWRC works to transfer existing technology to broader uses in controlling animal damage to agriculture. DWRC also collects scientific information to obtain new chemical registrations and to maintain existing registrations with the Environmental Protection Agency.

Research on Baiting for Coyote Control

Use of baits for selective coyote control potentially offers an economical means of reducing predation on sheep and other livestock. Field and pen studies to determine coyote acceptance of small baits have been conducted in Idaho, Utah, and Texas. Physical and physiological marking agents were incorporated in baits to simulate the use of toxicants or other chemicals in the field. It appears that more coyotes find and consume bait when new procedures for bait placement are used. Several methods of reducing bait-take by nontarget rodents and birds warrant further evaluation. Current work seeks ways to reliably deliver baits to a higher percentage of local coyotes throughout the year, to define causes of variability in bait acceptance, and to determine whether coyotes that accept baits also kill livestock.

M-44 Cyanide Ejector for Coyote Control Improved

The M-44 is a mechanical spring-powered device designed to propel a lethal dose of sodium cyanide from a plastic capsule into the mouth of a coyote. The device, registered for use in coyote control in 1975, often malfunctioned due to caking of the cyanide formulation or corrosion of the ejector mechanism. Implementation of research findings on improved capsule seals, corrosion treatments, and handling procedures appears to have reduced these problems for field personnel, and use of the device has increased. A new color marker was added to the sodium cyanide formulation in 1989 to replace the older material, which EPA had identified as a potentially toxic inert ingredient. Laboratory and pen research was initiated to identify selective coyote attractants that could be put on the device that would extend its use in warm months, when coyote response has typically declined.

Reregistration of Strychnine as a Vertebrate Pesticide

The APHIS ADC program has 13 registrations for vertebrate pesticides containing strychnine. In December 1987, the Environmental Protection Agency (EPA) issued a Data Call-In notice requiring all registrants of strychnine to provide laboratory and field data to support continued registration of

their uses. A subsequent Settlement Agreement between EPA and registrants clarified the data requirements. A Strychnine Consortium, including private industry, State agencies, and APHIS, funded contract studies on avian and aquatic toxicology during FY 1989. The Consortium is coordinated by DWRC, which performed the support work in analytical chemistry and protocol review for the contracts. In addition, DWRC conducted studies to generate data on environmental fate, product chemistry, nontarget hazards, and efficacy of strychnine baits.

Evaluation and Reregistration of Agricultural Rodenticides

Laboratory efficacy tests were conducted on plains pocket gophers to determine the lowest concentration of strychnine needed to cause 100 percent mortality. Six concentrations ranging from 0.31 to 1.55 percent were tested; as a result, we recommended field testing of concentrations of 0.35, 0.75, and 1.3 percent.

A pilot field study was conducted in Texas as an intermediate step between the laboratory studies and a larger field test, to evaluate the efficacy of the three strychnine concentrations (0.35, 0.75, and 1.3 percent) on plains pocket gophers. Bait was applied underground by hand, and mortality was determined by monitoring radio-equipped pocket gophers.

Herbicide Application Evaluated as Technique for Blackbird Dispersal

In a study to develop a method for reducing blackbird roost habitat near sunflower fields, 70 percent of the cattails in four marshes were aerially sprayed, in August and September, with Rodeo herbicide at a rate of 2.5 to 3.0 quarts per acre in a 5-gallon-per-acre solution. The untreated, or control, cattails (30 percent) were in 45-foot-wide strips. Blackbirds and nontarget animals in and around the marsh were surveyed pretreatment and posttreatment. Surveys were made of blackbirds that used sunflower fields within 2 miles of the treated marshes as feeding grounds. In addition, Rodeo at one of three application rates (1, 2, and 3 quarts per acre) was applied in 8-foot strips by ground sprayer in one marsh. Initial data indicate that Rodeo herbicide applied aerially at about 3 quarts per acre in a 5-gallon-per-acre aqueous solution is effective for killing low- to medium-density stands of cattails but may be inadequate for killing heavy stands of cattails. Rodeo herbicide applied aerially at 3 quarts per acre in a 10-gallon-per-acre aqueous solution may be more effective on heavy stands of cattail. Estimates of pretreatment and posttreatment populations of target and nontarget birds in the marshes were similar. There were no differences in the number of blackbirds observed in the sunflower fields pretreatment and those observed posttreatment. The effectiveness of the herbicide applications will be evaluated in July 1990 by determination of the density of emerging cattails in the treated marshes. Heavy rains in late August and early September 1989

precluded burning or mechanically crushing the cattails in the treated wetlands, as had been planned.

Development Continues of Blackbird-Resistant Sunflower Hybrids

Experiments were conducted to quantify the effectiveness of individual bird-resistant traits possessed by sunflower hybrids being developed by scientists at North Dakota State University. In these trials, the roles of hull thickness, head shape, length and heaviness of leaves surrounding the sunflower head, and head orientation were investigated. Methodology was developed whereby the presence of variations of these traits (for deterring blackbird feeding) was related to the amount of white millet and green foxtail normally consumed by red-winged blackbirds. Initial analysis of the data indicates that a concave head facing down may be the most important morphological trait for deterring blackbird feeding. Variations in bract size and hull thickness do not appear to significantly deter bird feeding on sunflowers. These data will be used to help select sunflower genotypes with potential traits for bird resistance.

Aerially Applied Toxicant Tested in Winter Blackbird Roost

A candidate chemical for controlling winter blackbird roosts was evaluated under an Experimental Use Permit in March 1989. A 5.5-acre bird roost site near Crawford, MS, containing about 330,000 blackbirds and starlings was treated by helicopter at night with a solution containing 50 pounds of CPT-Avicide mixed with water to equal 50 gallons, applied per acre. Total treatment-related mortality of birds within the roost was estimated to be 9,500 blackbirds and starlings. Mortality of birds away from the roost was estimated by roost counts, monitoring of radio-tagged birds, samples of surviving birds leaving the roost, and monitoring of blackbird numbers within the birdshed of the roost. These mortalities indicated a population reduction of 10-50 percent, with most mortality occurring within 3 days after treatment. The impact of this spray on nontarget species appears to be minor. Numbers of hawks and owls in and near the roost did not decline following treatment nor did the number of hawks within the birdshed of the treated roost. Dead nontarget birds found during posttreatment roost searches included 10 cardinals (Cardinalis cardinalis) and 1 robin (Turdus migratorius). Nine of the 11 nontarget dead birds showed signs of CPT poisoning.

Dispersal of Cormorant Roosts Not Effective in Reducing Catfish Losses

A study was conducted at three cormorant roost sites to determine if roost dispersal would result in reduced cormorant depredation at nearby catfish ponds. Although cormorants appeared to be easily frightened from roosts by both ground-based and aerial harassment, the effect on damage reduction was less evident. After dispersal, some short-term reduction of birds at nearby ponds was recorded during aerial surveys; however, the birds formed new roosts at the closest available roost habitat or at nearby historical roost sites.

Cormorants continued to feed at catfish ponds near these areas. The simultaneous harassment of cormorants at two roosts (10 miles apart) by helicopters, fixed-wing aircraft, and ground-based personnel resulted in the birds flying between roosts, adapting somewhat to aerial harassment by diving into the water rather than leaving the site, or temporarily relocating to other unknown roost sites. Based on this study, it appears that all potential roost sites would have to be harassed at the same time in order to move cormorants out of the region.

Catfish Growers Surveyed

As the first step in a study on the impact of fish-eating birds on commercial catfish operations, Mississippi catfish growers were surveyed by telephone. These birds were enough of a problem to 94 percent of the growers that they conducted bird-harassment activities. Driving around the ponds and discharging firearms to scare the birds was the primary harassment technique used by 90 percent of these growers. The total annual cost of harassing birds for these growers was roughly $1.5 million. This amount does not include the value of the fish lost to birds. Methodology for estimating this loss is being developed in a separate study.

Clay Coating Evaluated as a Bird Repellent

In cooperation with the Texas A&M University Agriculture and Extension Center in Beaumont, TX, a field study was conducted to evaluate the effectiveness of clay-coated rice in reducing bird damage. In two of three test fields, substantially fewer sprouts were lost from 1-acre plots sown with coated seed than from adjacent 1-acre control plots. The results of this study are consistent with previous findings, and further development is planned for a more reliable and effective formulation of the clay coat.

Plant Compounds Evaluated as Bird Repellents

Plant secondary compounds that deter insect predation might also serve as bird repellents. This possibility was tested using cucurbitacin, an insect antifeedant compound present in buffalo gourd and other members of the family Cucurbitaceae. The data suggest that ground buffalo gourd is an effective bird deterrent at concentrations of greater than 2 percent. Because cucurbitacin is readily available at low cost (in a variety of gourds and squashes) and because it is insecticidal, further examination is believed to be warranted. In particular, this substance could have utility as an insecticidal "cofactor" in pelleted insecticides; that is, cucurbitacin would permit use of a lower concentration of hazardous chemical insecticide while providing enhanced protection against accidental ingestion of pellets by birds.

HUMAN NUTRITION INFORMATION SERVICE

The Human Nutrition Information Service (HNIS) develops, through applied research, information required to improve public understanding of the nutritive value of foods, the nutritional adequacy of food supplies and diets, and the selection of nutritious and healthful diets. The agency compiles information on food composition; monitors food and nutrient consumption by U.S. households and individuals; measures consumer awareness, understanding, and attitudes about diet and health relationships and dietary guidelines through national surveys; and develops materials and techniques to help Americans improve their nutrition and reduce the risk of disease through better diets.

1989 Continuing Survey of Food Intakes by Individuals Conducted

The Continuing Survey of Food Intakes by Individuals (CSFII) was reinstated in 1989 and is planned yearly through 1996. The data collection began in April 1989 and was completed in March 1990 for all members in 1,500 households in the general population and in an additional 750 households in the low-income population. The survey is designed to obtain data on food intake for 3 days from all members of the household in addition to sociodemographic data and general information on each respondent's diet and health. Data reporting will be accomplished using a moving-average approach. It will provide annual 3-day estimates of dietary status for men and women 20 to 49 years old after 2 years of data collection beginning in 1990, with estimates for the other sex/age groups after 3, 4, or 5 years.

Diet-Health Knowledge Survey Initiated

With the 1989 Continuing Survey, a new type of survey was initiated to assess the dietary knowledge and attitudes of survey participants. It is called the Diet-Health Knowledge Survey (DHKS) and was conducted as a telephone followup with only the main meal-planner/preparer in the household. The two major purposes of the survey are to improve the understanding of factors that affect food choices, and to obtain information on people's knowledge and attitudes about the concepts promoted by the Dietary Guidelines for Americans. This survey is the first time that a nationwide survey will be used to study the relationship between individuals' actual dietary intakes and their attitudes about dietary behavior.

1987-88 Nationwide Food Consumption Survey Reported

The 1987-88 Nationwide Food Consumption Survey (NFCS) is the sixth decennial food consumption survey conducted by USDA since the first in 1935-36. The NFCS includes two components: household use and cost of food for a 7-day period (household component), and intake of food by individual household members for a 3-day period (individual component). Data analysis is under way for preparation of a series of 21 statistical reports and popular chartbooks. Reporting, which will begin in early

1991, will include (1) popular chartbook publications highlighting findings for the popular press and lay audience through charts and pictures, (2) individual intake publications providing statistical tables and brief discussion of data for both 1-day and 3-day individual intakes, (3) household publications providing statistical tables and brief discussion of data on household food consumption and dietary levels, and (4) methodology publications providing detailed information on sample design and survey methodology.

Methodology of Food Consumption Survey

HNIS maintains an active program in survey methods research. Since 1975, 12 major studies of survey methods have been completed by investigators at universities and private research firms. These studies are documented in "USDA Methodological Research for Large-Scale Dietary Intake Survey 1975-88." This unique resource includes information on where the survey methods were appropriate and where changes were needed.

National Nutrition Monitoring System Issues Second Report to Congress

USDA and the Department of Health and Human Services (DHHS) have implemented a reporting system that integrates results of the National Nutrition Monitoring System (NNMS) components into common reports. Two such reports have been sent to Congress--the first in 1986 and the second in 1989. The second report is entitled "Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring." It updates information (since the first report) on the dietary and nutritional status of the U.S. population as well as factors that influence that status. The report also includes an indepth analysis of NNMS contributions in evaluating the relationship of dietary and nutritional factors in cardiovascular disease and in iron nutriture. Data from USDA's Continuing Survey of Food Intakes by Individuals, Nationwide Food Consumption Survey, and U.S. Food Supply Series are among the key sources of information in the report.

Data Issued on Nutrient Content of Lamb, Veal, Game, Cereal Grains, and Pasta

Revision and publication of Agriculture Handbook No. 8, "Composition of Foods," has been ongoing for the past several years. The handbook is being revised in sections. Two sections were published in FY 1989: "Lamb, Veal, and Game" (AH-8-17) and "Cereal Grains and Pasta" (AH-8-20). Also published this year was the first periodic supplement, which includes updates of previously published data and data for new items.

Nutrient Data Bank Bulletin Board Established

The Nutrient Data Bank Bulletin Board was developed as a public service to persons interested in obtaining information about nutrient data via online computer. The board is operated 24 hours a day, 7 days a week, to provide information about all current HNIS publications and computer files on the nutrient composition of foods, announcements about Nutrient Data Bank Conferences, and other relevant topics. The information is in

the form of bulletins that can be viewed directly or captured (saved) on a disk for review at the user's convenience. In addition, small files on nutrient data are available for use on the user's personal computer. To access the bulletin board, an individual needs a computer, a modem, communications software, and a telephone to call the board (301-436-5078).

Cost of Food at Home Published

The cost of four USDA family food plans--thrifty, low-cost, moderate-cost, and liberal--was released monthly in FY 1989. The thrifty food plan is used as the basis for benefits in the Food Stamp Program.

Federal Dietary Guidelines Advisory Committee Established

A Federal Dietary Guidelines Advisory Committee was established by USDA and DHHS to review recent scientific evidence on diet and health relationships and to determine if revision of the 1985 edition of "Nutrition and Your Health: Dietary Guidelines for Americans" is warranted. The nine-member committee of health and nutrition experts determined that revision of the 1985 edition of the Dietary Guidelines is needed, and the members are developing their recommendations and rationale for the revisions. The Committee's report of recommendations for revision will be given to the Secretaries of USDA and DHHS. These recommendations will be used by the two Departments to prepare a third edition of the Guidelines to be issued in 1990.

"Eating Right . . ." Campaign Launched

A new campaign for consumer nutrition education, called "Eating Right . . . The Dietary Guidelines Way," was launched. The purpose of this major nationwide campaign is to increase awareness of the Dietary Guidelines for Americans and to help people put the Dietary Guidelines into action in their lives. The focus of initial campaign efforts is to reach the public with the Dietary Guidelines message through the media and other information multipliers as well as through professionals in the public and private sectors who interact with the public. The campaign kickoff was the release of four new consumer booklets containing practical advice for consumers on fixing quick meals; shopping for and preparing food; planning menus; making bag lunches, snacks, and desserts; and eating out. The booklets are in a magazine-style format, with color photography, illustrations, charts, and recipes.

Factsheets on Good Sources of Nutrients Issued

A series of factsheets on good sources of nutrients was developed to help consumers select foods, as they follow the Dietary Guidelines, that contain adequate daily amounts of the nutrients. The nutrients include nine vitamins, seven minerals, and dietary fiber. Each factsheet includes information on the need for the nutrient, good food sources, and how to prepare foods to conserve the nutrients.

AGRICULTURAL MARKETING SERVICE

Market research and development in the Agricultural Marketing Service (AMS) help to minimize the cost spread between agricultural producers and consumers by finding new ways to increase food-marketing efficiency. The agency's research encompasses three main efforts: (1) planning wholesale food distribution centers and farmers' markets to address specific facility problems hampering food marketing, (2) conducting method-improvement studies to increase the efficiency of specific food wholesaling and processing activities, and (3) identifying new market opportunities and related facility requirements to support expanded agricultural production directed toward opening additional sources of income for producers.

Assembly, Initial Processing, and Brokerage Facilities Designed for Southwestern Michigan

A cooperative AMS-Michigan State University study resulted in plans for a unique combined assembly, initial processing, and brokerage facility to serve fruit and vegetable producers and buyers. The new building would be adjacent to and become a part of the existing Benton Harbor Fruit Market. Study findings indicate that a lack of modern and efficient marketing facilities hampers the production of marketable crops in the area and has led to a loss of market share nationally for regional producers. The new facilities would cost about $5.7 million and would serve the southwestern Michigan fruit and vegetable industry. Concepts illustrated in this research may also have application in other agricultural producing areas that seek production diversity for economic and other objectives.

Growth of Maryland Wholesale Food Center Studied

In a comprehensive study of the value of relocating in improved food distribution centers, researchers identified additional wholesale-food-firm groups that could benefit by locating in the Maryland Wholesale Food Center (a 400-acre wholesale food distribution center between Baltimore, MD, and Washington, DC). These firms currently have annual sales exceeding $640 million. Development plans for the center include buildings designed to allow moderate-size companies to realize many efficiencies normally associated with larger firms. Research indicated that companies located in this modern food center were able to expand sales and reduce marketing costs compared with similar operations elsewhere or with their own operations prior to relocation.

Marketing Facility Plans for New York Meat Wholesalers

A study of alternative plans for inner-city wholesale meat firms in West Harlem, NY, led to the design of modern processing facilities that can be constructed on the Hunts Point Food Distribution Center in the Bronx.

Relocating these firms would support alternative land use and enhance the employment and tax base in Harlem, while preserving the economic activity of these firms within the city. Interior layouts for these new buildings were developed in cooperation with the Food Safety and Inspection Service and represent the application of advanced technology and food safety considerations.

Study Plans Developed for Major Food Centers

Researchers have initiated planning to evaluate the need for new marketing facilities to serve the Chicago, IL, region. Other studies in advanced planning include evaluations of the potential development of new marketing facilities to serve South Carolina and Maine.

Regional Food Marketing Facilities for Phoenix, AZ

Findings of a study of the potential for developing new food distribution and processing facilities to serve the Phoenix, AZ, area include plans for a new wholesale food center. This new center would require an approximately 80-acre site and require investments of about $33 million, excluding land costs. The new development could generate about 1,700 new jobs (direct and secondary), adding about $150 million to the regional economy. Research findings also include plans for special support facilities and infrastructure intended to take full advantage of grouping large numbers of food firms in a market center environment.

Technical Assistance Extended To Supplement Research and To Improve Existing Market Facilities

Efforts continue for developing new ways to improve existing food centers as an alternative to developing completely new markets at other locations. An example of such activity is the formulation and assessment of alternative ways to expand the capacity and increase the efficiency of the New England Produce Center in Boston, MA. AMS researchers also continue to work with State and local authorities and with regional food-industry groups, in their efforts to carry out market-development plans outlined in previous research studies. Examples of this activity are (1) continued construction of a new market complex to replace the existing Raleigh State Farmers' Market in Raleigh, NC, and (2) work on the first phase of redevelopment of the Central New York Regional Market in Syracuse, NY.

Vegetable Marketing

In 1989, six cooperatives participated in the Horticultural Producers Federation's centralized marketing program, with 294,144 boxes of five different vegetables sold. Gross sales totaling $1.777 million consisted of tomatoes at $976,000, cabbage at $464,000, green peppers at $212,000, squash at $100,000, and sweet corn at $25,000. Product quality was good except for some of the cabbage, which had received too much rain. The Federation plans to market 477,300 boxes in 1990, at an estimated gross of $2.755 million. Much of the additional

volume is expected to come from Sand Mountain Cooperative, Henegar, AL, as sweet corn and cucumbers. Tennessee Valley Authority is assisting the cooperative members in acquiring irrigation equipment for sweet corn. Farm groups in Arkansas, Mississippi, West Virginia, Tennessee, and Oklahoma have attended the Federation's annual meetings and have indicated interest in joining it.

Alternative Marketing Opportunities Project

The objective of this project is to provide useful and accurate research results and assistance to farm groups to help them evaluate alternative crops and enterprises. The project was initiated after AMS received many requests from farmers for information on marketing vegetables. Many requests were also received after copies of Marketing Research Report 1146 were supplied to hundreds of persons nationwide. Additional research results will soon be available in another marketing report, "Opportunities for Fresh Fruit and Vegetables Using Market Windows and Expected Value Analysis." This work is helping many small farmers produce and market products that result in more profits per acre, compared to profits from corn and soybeans.

Aquaculture Marketing

Research is under way on marketing of catfish in Oklahoma and Kentucky and hybrid striped bass in Maryland. Objectives of the research are to determine the size and number of actual and potential catfish producers and potential markets in and around Oklahoma; determine the extent of death loss and monitor the transport environment (temperature, pH, and dissolved oxygen) during shipments of live fish in Oklahoma and Kentucky; compile a list of producers in Kentucky and cooperate in the building and operation of a demonstration catfish-processing plant; and develop and test methods and facilities for processing and marketing hybrid striped bass in Maryland.

Feasibility of Exporting Fresh Vegetables to the Pacific Rim Countries

Projects are under way to conduct test shipments of fresh vegetables from Washington and melons and melon balls from Oregon. This work is being done in cooperation with the International Marketing Program for Agricultural Commodities and Trade Center (IMPACT) and Oregon State University. Small quantities of fresh vegetables will be surface-shipped to determine if the products arrive in satisfactory condition for marketing. Tests will be conducted to produce and market melon balls and melon popsicles from the supersweet Japanese melons.

Development of Standard UPC/PLC Coding System for Produce

Work is continuing with the Perishable UPC Random Weight Ad Hoc Committee to apply generic UPC codes to all packages of fixed-weight produce, to standardize all price lookup numbers (PLC) for produce throughout the United States, and to standardize item numbers for all variable-weight packages of produce. An AMS industrial engineer represents USDA on the Ad Hoc Committee.

Shiitake Mushroom-Marketing Project	As a result of numerous requests for information from small producers of shiitake mushrooms, AMS personnel provided both research and technical assistance. The research assessed the size of the U.S. shiitake market and determined the market's expected rate of growth. Investigations have been started to determine the strategies that can be developed for small producers to use in positioning their products in the market place. Several presentations have been made to industry groups, and assistance is being provided in analyzing consumer demand. A product-packing and test marketing project was conducted in southeastern Virginia. The project was videotaped, and a report is being published.
Feasibility of Alfalfa-Cubing Plant	This study analyzed the economics of constructing and operating an alfalfa-cubing plant in the Midwestern States. A decline in cattle and other factors resulted in surplus hay in some years and in some areas. This research evaluates the market potential for hay cubes and the costs and benefits to farmers. The facility and equipment requirements, layouts, and feasibility portion of the study were presented to the Southwestern Iowa Hay Growers Association. The results of this study will be published for use by groups in other areas of the country.
Farmers' Assembly Market in Northern Kentucky	A study has been conducted to analyze the need for and feasibility of including facilities for assembling, washing, cooling, grading, and packaging fresh vegetables in a new farmers' market in northern Kentucky. The study includes the feasibility of both wholesale and retail operations for food products, nursery stock, garden supplies, crafts, and support businesses. The study is a cooperative effort with the Northern Area Development District, the Kentucky Department of Agriculture, and the Extension Service. A manuscript has been completed and should be published soon.
Certification of Growers of Organic Food	Researchers examined various programs in operation for certifying growers of organic food and described their basic elements. This information will be available to public and private organizations that are formulating their own certification programs for organic growers. The organic food industry topped $5 billion in 1989. Basic requirements for an effective certification program include a specific organizational objective and description; a strong commitment of qualified personnel; adequate equipment and structures; an appropriate budget with sufficient travel authority; and an extensive, ongoing training program.

OFFICE OF TRANSPORTATION

The mission of the Office of Transportation (OT) is to help develop an efficient agricultural transportation system that will improve farm income, expand exports, and meet the needs of rural America. OT provides technical and administrative direction, coordination, and leadership in the development and execution of the agricultural and rural transportation policies and programs of USDA.

Railcar Shortage for Shippers

In recent years, almost no new grain cars have been added to the Nation's railcar fleet. Problems of grain car availability in early 1988 led to concern and debate over the ability of the U.S. rail system to meet future grain transportation needs. In 1989, OT published a study that quantified the likely supply and availability of railcars for grain in future years. This study, "Railcars for Grain: Future Need and Availability," is an authoritative document for policy considerations by industry and by regulatory and judicial agencies.

Panama Canal Analysis

The 1989 crisis in Panama sparked a study to determine the effect on agricultural exports if, for some reason, the Panama Canal were closed. OT determined that 33 million metric tons of U.S. grain passed through the canal in FY 1988. This figure is 28 percent of all U.S. grain exported and 65 percent of all U.S. grain exported to the Far East. In addition to grain, U.S. cargoes of beans, canned food, cotton, flour, lumber, peas, refrigerated foods, sugar, tallow, tobacco, vegetable oil, and wool transit the canal. If the canal were closed, carriers out of Gulf ports would have to travel farther (through the Suez Canal or around Africa or South America) to reach Far East markets. The cost to deliver U.S. grains to Asia would probably increase by about $6.50 per metric ton.

Monitoring of Livestock Directives of European Community

OT has been working with the International Air Transport Association, the Animal Transport Association, and other USDA agencies (Animal and Plant Health Inspection Service, and Foreign Agricultural Service) to monitor European Community (EC) directives that will affect live animal exports. The directives cause concern because they may require all live animals moving into or through EC countries to be removed from transport vehicles for inspection at a limited number of border ports. Such a requirement would increase the cost of U.S. livestock shipments to Africa and the Mideast as well as within EC, and could add undue stress to the animals. The effect could be to make U.S. livestock noncompetitive in certain markets. A position paper, requesting modifications in this directive, was prepared and submitted to the EC Commissioner.

Coordination of Mexican Border Transportation

Logistical coordination of agricultural trade between the United States and Mexico began in the late 1970's when the volume of agricultural trade between the two countries increased significantly, particularly shipments of U.S. grain into Mexico by rail. Because of the logistical problems resulting from this increased trade, CONASUPO (the Mexican government food-purchasing agency) and USDA agreed to establish (1) a bilateral transportation group to meet once or twice a year to address these problems and (2) a coordinator in each of the two agencies to handle periodic logistical problems. The USDA border coordinator is a staff member in OT.

OT organized a meeting in Mexico in May 1989 involving CONASUPO, USDA officials, and over 350 representatives of grain merchandisers, grain importers and purchasers, and rail carriers interested in improving the logistics of U.S.-Mexican agricultural trade. The USDA border coordinator is also involved daily with border transportation problems relating to inspection and with customs or border interchange that may develop on U.S. agricultural exports to Mexico.

Grain Movement by Barge Monitored

With the cooperation of the U.S. Army Corps of Engineers, OT continued to monitor the volume of major agricultural products transported by barge along the Mississippi River System. Each week, OT records the amount of corn, wheat, and soybeans that pass downriver through seven strategic locks and dams on the Arkansas, Illinois, Mississippi, and Ohio Rivers. The monitoring of barge traffic assists OT in examining trends of the U.S. agricultural export market and in providing policy guidance to USDA. The weekly data are released via OT's "Grain Transportation Situation" report and USDA's system for electronic communications.

Protecting Animals During Air Shipment

OT recently released a tip sheet on "Protecting Animals During Shipment in Aircraft Baggage/Cargo Holds." Cattle, swine, baby chicks, and honey bees worth over $125 million are shipped overseas annually in the lower or baggage compartments of passenger aircraft. Occasionally animal losses occur in the lower compartments due to poor ventilation, extreme temperatures, and improper handling. This tip sheet provides shippers and carriers information on the available ventilation in the cargo compartments of the more common commercial aircraft. Recommended handling procedures and calculations for determining the proper load size are also provided.

Backhauling Garbage in Food Trucks

Publicity in spring 1989 concerning the hauling of municipal garbage and trash in the same vehicles that haul food products led to the formation of an intergovernmental task force, headed by OT, to address this issue. Other involved agencies include USDA's Food Safety and Inspection Service, the Environmental

Protection Agency, the U.S. Department of Transportation, the Interstate Commerce Commission, and the Food and Drug Administration.

As part of the resulting educational effort, OT prepared three tip sheets: "Regulations Governing Sanitation in Vehicles Transporting Food," "Regulations Governing Construction Materials and Cleaning Compounds for Vehicles Transporting Food," and "Regulations Governing Joint Use of Vehicles Transporting Food and Hazardous Materials." These tip sheets provide shippers with lists of (1) regulations and their enforcing Government agencies, (2) reference publications and where they can be obtained, and (3) contact points within the Government for additional information. These publications were widely publicized through trade associations and directly distributed through the mail and electronic information services.

Reducing Transport Damage to Produce

OT began a research project at its Beltsville, MD, laboratory with the goal of reducing the vibration damage occurring during the transportation of grapes and strawberries. Losses from shipping damage to these commodities exceed $20 million each year.

The study was requested by Dole Fresh Fruit, the California Grape and Tree Fruit League, Fruehauf Corporation, and the Agricultural Research Service. Using fruit donated by Dole, the experiment simulated the shocks and vibrations on loads of fruit during transcontinental shipment. Once the exact cause of the damage is determined, OT will work with the truck trailer and carton industries to reduce damage levels.

Rural Bridge Conditions Studied

As part of an effort to address the Nation's problem of deteriorating bridges on rural highways, OT completed a study of the situation based upon data maintained by the U.S. Department of Transportation. The study report, "Rural Bridges: An Assessment Based Upon the National Bridge Inventory," compares rural and urban bridges and highlights rural bridges in agriculturally significant counties.

Timber Bridge Initiative

OT continued working with USDA's Forest Service and other agencies and organizations to implement a technology transfer plan for timber bridges, including the development and dissemination of timber bridge information and the conduct of onsite demonstrations. During FY 1989, OT coordinated the development of a brochure titled "Modern Timber Bridges: A Viable Alternative for Rural America." This brochure was published by the National Forest Products Association as part of the overall effort, and OT assisted in distributing it to rural officials throughout the country.

Small Railroads for Rural Areas

Over the past decade, the most significant development in rail transportation has been the emergence of small railroads as a viable means by which rail service can be maintained to the rural areas of the United States. OT issued a report entitled "Importance of Small Railroads to Agriculture and Rural America" in August 1989. This contains information on the historical development of small railroads, the current policy issues, and the interest of agricultural and rural communities in the continued development of small railroads.

OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

The mission of the Office of International Cooperation and Development (OICD) is to coordinate international cooperation in agriculture and related fields.

International research and education programs include scientific and technical exchanges, management of collaborative research, representation of USDA and U.S. Government research and education interests in international organizations, and training and facilitation of private sector involvement in agricultural development and cooperation. Programs are conducted cooperatively with other USDA and U.S. Government agencies, universities, and the private sector.

Hill Land Pasture Improvement in Collaboration With Spain

West Virginia, like Galicia in northwestern Spain, has thousands of acres of steep, hilly, brush-infested pastures. Both locations have animal production systems based on sheep or goat grazing. Under terms of an award from the U.S.-Spain Joint Committee on Scientific and Technological Cooperation, teams of animal production specialists and agronomists at West Virginia University and the Ministry of Agriculture in Galicia carried out extensive studies to increase animal production and brush control in these problem situations.

The impact of this joint work, when applied, can improve pasture production and animal yields in over 14 million acres of brush-infested, hilly pastures in U.S. Northeastern States. West Virginia animal production specialists estimate that low-cost methods of brush control and pasture improvement resulting from this work can lead to an annual savings of $280 million in the Northeastern United States.

Epidemiology of Bluetongue in Central America and the Caribbean

Collaborative research in the Caribbean focused on bluetongue virus, a disease that constrains the international trade of cattle and sheep. Bluetongue is a viral disease of domestic ruminants. The proximity of infected livestock in nearby countries threatens the productivity of U.S. livestock. A bluetongue epidemic in Mississippi, for example, caused the cattle industry an estimated $6 million loss. Detection of the disease in Florida and Alabama in the early 1980's spurred the need for further research on the occurrence of various types of bluetongue virus infecting livestock in Central America and the Caribbean.

The Universities of Wisconsin, Florida, and Alabama, with support from USDA's Office of International Cooperation and Development, Cooperative State Research Service, and Agricultural Research Service (ARS), conducted cooperative research with regional organizations concerned with animal

health in Central America and the Caribbean. Results show that the movement of the insect carriers of the virus is a more important factor in its spread than the international movement of animals.

Improvement of Wheat Disease Resistance by Use of Wild Germplasm

New sources of disease resistance remain to be discovered in the wild species closely related to wheat. In a 5-year foreign-currency research project in India, disease resistance was transferred from wild plant species into wheat breeding lines. Indian scientists at Punjab Agricultural University screened germplasm from wild plant species for disease resistance in the laboratory and in the field. This work continues through an active 5-year replacement project on the transfer of new sources of disease resistance into modern wheats. New disease-resistant breeding lines are released to U.S. wheat breeders. USDA scientists expect the new germplasm from India to lead to higher yields and greater disease resistance in commercial wheat cultivars for U.S. farmers.

Improved Poultry-Processing Systems

Poultry carcasses chilled in a parallel-flow chiller system have more microbial contamination than carcasses chilled in a counter-flow chiller system. The magnitude of the difference is important from the standpoint of food safety and shelf life in the United States. Most U.S. poultry carcasses are chilled in the parallel-flow system.

Foreign-currency research from Yugoslavian scientists at the Food Technology and Biotechnology University, Zagreb, raises questions for U.S. researchers: Do the Yugoslav results hold true for the U.S. systems? If true, how can U.S. systems be modified to a more hygienic process? This 3-year study confirms that the counter-flow chiller system is more hygienic than the parallel-flow system. This finding challenges the U.S. scientific community and poultry industry to improve the quality of poultry meat processing.

Insect Biology Exchange With France

Building on a 1986 exchange visit, Dr. Herbert Oberlander of the Behavior and Basic Biology Research Laboratory, ARS, Gainesville, FL, visited France in September 1989 to continue his research on chitin and ecdysteroid metabolism in the Indian meal moth and the cabbage looper. His aim is to determine not only how ecdysteroids are produced but how they induce the transport of chitin precursors to outer-lying cells in insects in order to enable them to produce their hard outer covering. Through selective intervention in cellular processes in target insect species, scientists hope their studies will result in a biorational basis for controlling the development of major lepidopteran pests of field crops and stored grain and, ultimately, for reducing crop losses. Dr. Oberlander was one of

four recipients of USDA's prestigious "Outstanding Scientist of the Year" award in 1988.

Six Decades of U.S.-Mexican Collaboration

OICD, Animal and Plant Health Inspection Service, and the Mexican Secretariat of Agriculture and Water Resources (SARH) jointly produced and financed an English and Spanish publication highlighting "Six Decades of Agricultural Cooperation" in November 1988. The publication overviews programs and projects designed to solve many of the agricultural problems of concern to farmers in both countries. USDA and SARH have improved domestic agricultural production and international trade opportunities by working together as partners in areas of animal and plant health, preservation of natural resources, and sharing of scientific knowledge among universities and scientists from both countries. The publication is particularly significant because it highlights the agricultural interdependence of the U.S. and Mexico in trade and agricultural technology transfer.

Combatting the Desert Locust Plague in Africa and the Middle East

During 1988 and 1989 the African desert locust populations exploded to levels not seen since the plague levels of the 1950's. Weather conditions contributed to the rapid development of swarms that migrated as fast as 3,000 miles per month to 31 African and Middle Eastern countries. In areas of heavy concentration, a swarm of billions of locusts would denude 15 square kilometers of cropland in 1 day.

The lead U.S. Government international assistance agency, the Agency for International Development (AID), sought assistance from USDA as the primary source of technicians and supplies for locust control efforts. OICD's Technical Assistance Division coordinated USDA's response.

Coordinating contacts with other USDA agencies, State departments of agriculture, other Federal agencies, and the private sector, OICD identified and made available technical personnel, ranging from entomologists, aerial operations specialists, and logistics experts to environmentalists, program managers, and communication experts. Because of plague conditions and the unpredictability of locust swarms, a rapid response was critical. OICD staff members were frequently required to complete identification, clearance, and placement of technicians in the field within 1 week.

Due to the international response that minimized crop destruction, no African country suffered disastrous economic losses from the locust plague. In followup activities, OICD has coordinated regional training conferences in pest management, pesticide disposal, and other environmental planning activities.

International Science and Education Council

The International Science and Education Council (ISEC) brings together representatives of USDA agencies and the land-grant and State universities to encourage collaborative efforts in international agriculture in areas of mutual interest. In 1989, ISEC sponsored two major activities.

On April 10, 1989, the ISEC International Research Committee presented a conference entitled "International Agriculture Research: Its Relationship to U.S. Agriculture Productivity and Competitiveness." The objectives of the conference were to share information on the current status of international research and its benefits to U.S. agriculture, to explore various models for international collaborative research, and to seek advice on priority research issues and explore strategies for garnering greater support for international agricultural research.

The conference attracted a diverse audience of 100 persons, including USDA, AID, other Government agencies, university faculty and research administrators, representatives of private- and public-sector agricultural research organizations, and congressional staff. The keynote address was given by Dr. Leo Walsh, University of Wisconsin, who emphasized that international agricultural research is the major hope for sustained economic development in the world's poor countries. Walsh also indicated that international agricultural research indirectly benefits U.S. farming by building stronger economies abroad.

ISEC, Washington State University, the American Forest Council, and other USDA agencies cosponsored an international symposium, "Planning for Agroforestry," at Washington State University on April 24-27, 1989. The symposium provided a setting for developing methods that may be used in subsistence and commercial settings in both developed and developing countries. Significant international interest was seen, as evidenced by the 140 participants from countries such as Costa Rica, Pakistan, Senegal, Malawi, Philippines, Netherlands, Cambodia, Thailand, Indonesia, India, and Argentina. The opening plenary session was highlighted by a keynote address by Dr. Robert Buckman of Oregon State University and President of the International Union of Forestry Research Organizations.

FOREST SERVICE

The mission of Forest Service (FS) research is to serve society by developing and communicating the scientific information and technology needed to protect, manage, and use the natural resources of forested and range lands. Research results reduce the costs, improve the productivity, and enhance the efficiency of forest management while protecting or improving environmental quality.

FS research is conducted at eight regional forest and range experiment stations and the Forest Products Laboratory in Madison, WI. A total of 714 agency scientists at 74 locations produced nearly 2,200 publications in 1989.

Research on Atmospheric Sciences and Forest Fires

Research on forest trees suggests that current air-quality standards for ozone are insufficient to protect trees from ozone damage. Any increases in ozone emissions will only increase forest damage. Over the past decade, researchers have shown that the severity of ozone injury directly correlates with increasing exposure from north to south. The growth of affected Jeffrey pines in southern California has been reduced significantly during the past 20 years. Ponderosa pine seedlings showed significantly reduced photosynthesis and growth when exposed to concentrations of ozone simultating those in southern California.

Through laboratory testing and field research, computer systems now provide fire-related information on hundreds of plants, animals, and communities. These systems make it possible for fire behavior models to combine fire-danger information with fire-behavior predictions for a better understanding of the complex interactions of fuel, terrain, and weather. These interactions affect the movements and intensity of fires, the kind and amount of smoke produced, soil effects, expected regeneration, and ecological responses.

Research on Forest Insects and Diseases

Gypsy moth management currently emphasizes suppressing the rising populations before they cause defoliation. Outbreaks are patchy, however, and predicting the location of next year's outbreaks is difficult. Scientists analyzing 26 years of New England defoliation maps were able to identify regions in which gypsy moth populations develop outbreaks synchronously. An outbreak in one area increases the probability of other outbreaks beginning nearby, but suppression of an outbreak in one area is unlikely to prevent outbreaks 1 kilometer or more away.

Nitrogen fertilization of stands of trees infested with the western spruce budworm was found to reduce defoliation and significantly increase the radial and shoot growth of infested

trees. Although budworms increased in number and size, apparently more foliage growth was stimulated by the added nitrogen than was consumed by the increased budworm population.

Forest Inventory Research and Analysis

Systematic analyses of data from Pennsylvania's extensive atmospheric deposition monitoring system and remeasurements of permanent forest survey plots indicate that the decline of Pennsylvania's forests that is attributable to acid precipitation is not significant. The study analyzed forest and tree growth at varying levels of acid precipitation and also accounted for natural influences on forest growth, including drought and insect defoliation. It found a significant reduction in growth rate for only three tree species, two of which had been severely affected by gypsy moth defoliation in the past decade.

Inventories of pine timber have been increasing in the Southeastern United States for as long as most practicing foresters can remember. However, recent forest surveys of South Carolina, Florida, and Georgia indicate that pine timber volumes in the region have peaked, at least for now. The reasons for the downturn include increased removal of pine timber, reduced growth in some places, and decreased acreage of pine stands. Current rates of planting will sustain the existing levels of pine timber harvests. However, the continued expansion of forest industry will require a greater use of hardwoods.

Economics Research on Renewable Resources

Measures of productivity are important in characterizing the performance of the U.S. economy. USDA has published productivity indexes for the U.S. farm sector for decades, yet no national productivity indexes have been reported for U.S. forest resources. Economists in USDA and FS developed national measures of forest productivity for timber. These productivity measures reflect the performance of forests as measured by annual timber growth and harvest yields in relation to the timber inventory and timberland area. The measures provide a concise and comprehensive view of overall timber productivity in the United States for the past 35 years.

Urban Forest Research

Summertime temperatures in cities are 5 to 7 degrees Fahrenheit higher than those in the countryside, costing Americans billions of dollars for air-conditioning. Using computer simulations for different types of trees and their various placements around buildings, researchers projected the annual energy use in residences. They determined that, nationwide, planting the right trees in the right locations near homes may reduce summer cooling costs by 50 percent and winter heating costs by 15 percent. Costs for the planting, maintenance, and watering of trees were found to be small, considering the energy savings and environmental benefits. The added trees further cool the urban

environment as they transpire water from their leaves. As the trees grow, they take in carbon dioxide, thus reducing its accumulation in the atmosphere.

Trees and Timber Management Research

Researchers have developed methods of planting seedlings of many tree species and also a method of direct-seeding oaks to regenerate many acres of former wetland forests that were converted to agriculture over the past three decades under the Conservation Reserve Program. To date, the survival of seedlings established with this methodology has averaged 70 to 75 percent for oaks and 85 to 90 percent for other bottomland hardwoods.

The use of herbicides to control red alder in Douglas-fir plantations has been prohibited on national forest land in the Northwest since 1984. In studies to find substitute control methods, FS determined how alder sprouting is related to the age at which trees are cut, stump height, cutting angle, and the month in which they are cut. This research has produced guidelines for red alder control without the use of herbicides.

Management and Rehabilitation Research

FS scientists have collaborated with the National Aeronautics and Space Administration on several studies to assess methane production from natural processes. Anaerobic bacteria in waterlogged soils are major producers of methane. Scientists combined methane measurements in peatland in northern Minnesota with long-term environmental data to determine that the total annual methane production from Northern Hemisphere peatlands is approximately 198 million pounds. That amount of methane can trap as much heat as one-fourth of the carbon dioxide released from burning fossil fuels each year.

A 10-year research program has identified processes that are responsible for cycling and transporting compounds deposited from the atmosphere into groundwater and surface water. Sulfur and nitrogen compounds can cause shifts in water chemistry that mobilize nutrients and heavy metals, sending them to surface waters and affecting aquatic habitats.

Research on Wildlife, Range, and Fish Habitat

A recovery plan in Hawaii for an endangered bird, the palila, called for drastically reducing feral sheep populations in the palila's critical habitat. This action would allow the natural recovery of the native mamane forest tree, on which the palila depends. Scientists who monitored native plant recovery for 5 years after the sheep were removed found that native plants had reoccupied the slopes of Mauna Kea and that mamane had regenerated naturally.

Scientists who have studied the endangered red-cockaded woodpecker's habitat requirements for 10 years helped create a recovery plan in national forests and on other public lands in

the Southern United States. The plan calls for saving ample old southern pines for nesting and maintaining adequate acreage for foraging. Long-term observations in South Carolina show that these habitat provisions work. Breeding pairs of the red-cockaded woodpecker increased from 427 to 470 between 1980 and 1989. However, Hurricane Hugo destroyed much of that carefully preserved habitat in September 1989. In order to stabilize and restore the population, scientists worked quickly to cut artificial cavities in large standing pines where nest trees had toppled. The birds are now using more than a third of the 55 artificial cavities.

Forest Products and Harvesting Research

Researchers at the Forest Products Laboratory are exploring a completely new technique, biomechanical pulping, to reduce energy requirements, reduce chemical and other waste effluents, and increase pulp yields and paper strength. In this technique, wood is treated with selected wood-decaying fungi before mechanical pulping, resulting in large energy savings and stronger paper.

FS scientists have collaborated on mill-scale trials to apply the tannin-based adhesives developed in the laboratory for end-jointing lumber. The mill trials show that bonds equivalent to those found in the laboratory can be achieved in the mill. Half of the resorcinol normally used, at $1.90 per pound, can be replaced with tannin extract from southern pine bark at $0.25 per pound, and expensive radiofrequency curing is not needed.

International Forestry

The International Forestry (IF) program provides leadership, coordination, and direction for FS activities with other countries and organizations. In FY 1989, IF contributed as follows:

- Conducted technical reviews of approximately 90 proposals for the World Bank, the State Department's Man and the Biosphere Program, and the International Tropical Timber Organization.

- Advanced 23 cooperative research projects in seven countries. These projects addressed new technologies in agroforestry; fire management; insect and disease protection; regeneration; tree genetics; forest ecology; air pollution evaluation; and forest products testing, development, and marketing.

- Participated in 12 science and technology exchanges with 14 countries in eastern and western Europe, Asia, Oceania, and Latin America. These exchanges helped IF gain new information on forest products technology, management approaches to urban forestry and agroforestry, ecology of rain forests, insecticide resistance in plants, control of Armillaria and economically important termites, and habitat practices for forest wildlife and native salmon.

IF works closely with the U.S. Agency for International Development (AID) and the USDA Office of International Cooperation and Development in two programs established primarily to assist developing countries: the Forestry Support Program and the Disaster Assistance Program.

The Forestry Support Program accomplished the following:

- Organized a tree-seed-technology training course for participants from 11 East African countries and began an inventory of AID projects addressing tropical forests and biological diversity.
- Helped design an AID agroforestry project for Haiti, led a reforestation project evaluation in Burkina Faso, designed a forestry and soil conservation project in Tunisia, and analyzed Mexican environmental organizations.
- Prepared state-of-the-art documents on biotechnology, tree seeds, underused tropical species, biodiversity, and agroforestry.

The Disaster Assistance Program accomplished the following:

- Provided technical specialists for locust-control activities in Sudan, Senegal, The Gambia, Mauritania, and Algeria.
- Served on the interagency steering group for the International Wildland Fire Conference in Boston, which was attended by 400 persons from 39 countries.
- Provided advisors for a fire-suppression training course in Costa Rica and for an assessment of wildfire emergencies in Mexico.

FEDERAL GRAIN INSPECTION SERVICE

The Federal Grain Inspection Service (FGIS) conducts applied research in the process of fulfilling its mandate to administer the Nation's grain inspection and weighing system. FGIS is an action-oriented Agency with responsibilities to develop (1) new or improved methods and equipment for grading, inspecting, and weighing grain; (2) inspection standards; (3) inspection and weighing procedures; and (4) other grain-marketing services and programs. FGIS and the Agricultural Research Service (ARS) cooperate in establishing policies, responsibilities, and procedures for research in assessing grain quality. The Director, Quality Assurance and Research Division, shares with the Administrator the ultimate responsibility for overall planning, research, and related support programs and activities assigned to FGIS.

FGIS manages research outside the agency by reimbursable agreement with ARS or by contract with any acceptable vendor through the contracting capability of the Animal and Plant Health Inspection Service. Projects for which the personnel and equipment are available or reasonably obtained are handled within FGIS.

Classifying Wheat by Hardness

Determining wheat hardness by near-infrared reflectance spectroscopy and single-kernel hardness testers continues to be a high-priority project for FGIS. In recent years, the classification of wheat when it reaches the market inspection system has become more difficult and time consuming. Some new wheat varieties are almost impossible to classify "hard" or "soft."

To develop a sound classification system using new technology, several years of data collection and statistical analysis of the profile of all wheat marketed in the United States are essential. Using the recommendations of the Wheat Classification Working Group, FGIS is evaluating wheat crops from every region of the country and analyzing the yearly results. The purpose is to obtain data on how wheat in regular marketing channels would be graded if a hardness factor for differentiating between classes were used.

Screening Grain for Mycotoxins and Pesticides

Rapid procedures for determining the presence of aflatoxin in corn have been investigated. Six test kits for rapid screening for aflatoxin were evaluated against standard reference methods, and all six were approved for use in the official grain inspection system. This research project accomplished the objective of replacing the existing methods of determining aflatoxin with rapid, safe, and reliable methods.

In addition, FGIS evaluated quick pesticide-screening procedures that include the use of cholinesterase inhibition as the detection mechanism, but kits with these procedures failed to produce reliable and accurate results. FGIS is now pursuing different techniques for screening grain for the presence of pesticide residues. This will facilitate the development of a procedure that can be readily applied to grain analysis. FGIS procured a research-quality gas chromatograph/mass spectrometer for use in confirming pesticide contamination in grains and oilseeds.

Moisture, Starch, and Oil in Corn

The FGIS research team has developed a set of calibrations for moisture, protein, starch, and oil in corn. These calibrations were developed using near-infrared reflectance technology. The purposes are to provide more-objective testing for corn and to provide test results that are meaningful to end users. Work will continue on the refinement of the calibrations and their use in different types of near-infrared analyses.

Determination of Insect Infestation

Research continues to be performed on enzyme-linked immunosorbent assay, a promising new technique to detect insects and insect fragments in grain and in processed grain products. This research is being performed under contract with the University of Texas. Thus far, the new technique is valid for all types of insects that are common to grain.

ARS is developing an acoustic detection system that will be evaluated when delivered to FGIS. This acoustic system will detect live, hidden infestation with a sensitivity of one crawling or chewing insect in 1 kilogram of sample.

Toxicity of Weed Seeds

The toxicity of five different weed seeds that commonly contaminate grain is continuing to be investigated by ARS for FGIS. This is a long-term and extensive animal feeding study that involves examinations related to growth and development and studies of postmortem tissues and organs. Four seed studies have been completed. The fifth weed seed study is nearing completion.

Single-Kernel Moisture

A single-kernel moisture tester is being evaluated and shows promise for possible use in the grain inspection system. Determinations of single-kernel moisture detect the blending of high- and low-moisture corn. High-moisture corn may cause mold growth and heating and therefore cause the corn to deteriorate.

Identification of Grain Odor

Progress continues in the development of instrumentation to determine grain odor. This project has a high priority and is being performed by ARS for the benefit of FGIS. Odors are highly complex mixtures of organic volatiles. Identification of the volatiles responsible for a particular odor is an intriguing and complex process. The project has been redirected to examine only sorghum grain at this time. Refinement of the methodology should allow grain analysts to objectively determine odor in grain.

TCK Spore Detection

Recent controversy over the accurate detection of Tilletia controversa (Kuhn) (TCK) smut spores in wheat has caused the initiation of research into improved methodology for TCK detection. ARS planned for a research team from USDA and China to examine TCK analytical procedures. Fluorescence microscopy is the method of choice for the procedure. Fluorescence microscopy enables the analyst to differentiate several types of spores that have normally been perceived as having characteristics similar to those of TCK.

EXTENSION SERVICE

The Extension Service (ES-USDA) is the Federal partner in the Cooperative Extension System (CES) that helps people improve their lives through an educational process that uses scientific knowledge focused on issues and needs. Building on a strong tradition of program development based on sound educational theory and successful practice, Extension education brings research-based knowledge to bear on real-world problems. It combines the expertise and resources of Federal, State, and local governments and cooperates with other public- and private-sector agencies and groups in this effort. CES is a unique partnership among the Extension Service of USDA, Cooperative Extension Services in each State and Territory, and local Extension offices in nearly all of the Nation's 3,150 counties. More than 15,000 professionals and support staff, augmented by nearly 3 million volunteers, carry out the work of this nonformal educational system.

Through the development and implementation of national initiatives, programming of issues, and a strategic planning process, CES has moved into a more proactive role as a generator of innovation for the 1990's and into the 21st century. Through the national initiatives, Extension focuses significantly increased efforts on issues that are critical to the economic, environmental, and social progress of Americans. Educational programming and delivery for other high-priority and continuing areas of concern move forward through base programs. The programming of issues uses resources for matters of public concern at the national, State, and local levels. Extension's strategic planning process systematically manages change within CES by identifying emerging trends and issues that can be addressed by nonformal education, recommending development of new national initiatives to the CES leadership, and reviewing the status of existing national initiatives and recommending action on them.

During FY 1989, CES and ES-USDA moved forward in all these areas. There are now five national initiatives, and a sixth is being developed. The strategic planning process heightens the awareness of emerging and current issues, and programming of issues fosters the development of programs in these areas. Summaries and highlights of these efforts follow.

Increasing Agricultural Competitiveness

Emphasis on improved profitability through integrated crop and livestock production systems continued in FY 1989 with more focus on sustainable agriculture and international marketing. In most States, interdisciplinary teams promoted the adoption of agricultural systems that integrate financial planning, marketing, and production efficiency in ways that meet producers'

goals. Educational programs emphasized the careful use of inputs, including fertilizers, herbicides, and pesticides, and also the production systems for beef and other livestock. More producers used computerized financial planning programs and expert systems, and gave increased attention to the integration of marketing and production plans. Producers in areas impacted by drought in 1988 and 1989 were helped to adapt to those conditions. Selected programs of assistance include the following:

- Technical assistance to increase production efficiency in commercial cropping systems combined with programs to improve competitiveness in world markets, e.g., collaboration with other public and private organizations to develop a Total Beef Program that involves producers, lenders, and others in adding to the value of beef produced.

- System approaches that encompass economic and environmental considerations while contributing to overall productivity. An example is the Integrated Pest Management Program, which is conducted throughout the United States. The program has expanded to over 50 commodities and represents an investment of over $15 million annually in public funds.

- Whole farm optimization models and expert systems that aid farm families in (1) analyzing strengths and weaknesses of the farm business and (2) improving decisionmaking in the marketing and production of crop and livestock enterprises. Specific programs help to reduce crop-input costs and to improve feedlot performance by improving production efficiency and profitability.

- Educational programs that assist producers in planting during optimum time periods and also computer simulation models that indicate fertilizer rates and irrigation schedules to achieve maximum yields in cotton, rice, and other crops. Other programs concern the timely harvest of crops to improve the quality and quantity of the product.

- Programs that develop least-cost rations and provide other management assistance to help dairy producers and other producers deal with the current and lingering effects of drought and also improve their competitive positions.

Improving Water Quality

Water quality is the focus of a major effort conducted by CES in cooperation with other agencies and institutions. Through a national initiative and related base programs, CES is leading joint efforts and conducting other educational programs that focus on preventing further pollution and improving water quality in agricultural and rural communities. Cooperation in the

national initiative by State Cooperative Extension Services (SCES's) throughout the Nation has brought forth many individual projects that emphasize the use of management practices and training that will reduce or prevent further degradation of the water supply. These educational programs concentrate on improving water quality by (1) informing producers about the interactions of soil, nutrients, pesticides, and water quality and about corrective actions that may be taken, and (2) assisting rural residents in improving the safety of drinking water. Some of the efforts conducted are as follows:

- Joint leadership by the ES-USDA and the Soil Conservation Service in on-farm projects demonstrating cost-effective agricultural practices and new water-quality technologies. These projects were funded at $3.3 million for FY 1989.

- Educational programs in many States across the Nation on the best management practices to reduce or prevent further degradation of the water supply. These include multidisciplinary approaches that identify levels of contamination and reduce nonpoint sources of pollution.

- Training programs and educational materials for pesticide applicators. Over 250,000 private and commercial pesticide applicators were trained by SCES's. Educational materials on calibration, pattern testing, safe use of chemicals and equipment, and wash-water disposal were developed and made available to applicators.

- Toxic-waste-cleanup events organized by SCES's to promote the proper disposal of agricultural and homeowner toxic wastes. These include paint, pesticides, motor oil, solvents, aerosols, and car-care products.

Conserving and Managing Natural Resources

Through ongoing programs, CES is fostering improved management of the Nation's forest, rangeland, and wildlife resources. These programs support continuing crop and livestock production while increasing the awareness of the interaction between agriculture and the environment. These efforts encourage integrated approaches that allow simultaneous production, recreation, wildlife management, and habitat improvement. These programs include

- Coordinated resource management areas, in a number of Western States and encompassing millions of acres, that facilitate multiple use, resolve land-use conflicts, and increase public involvement. These programs include rangeland weed control and demonstration grazing systems that result in increased production and in savings to owners of range and forest land.

- Forest management educational programs, in all regions, that disseminate information on marketing, addition of value to products, and cost-reducing practices. This information reached nearly 200,000 landowners in FY 1989. These and similar programs encouraged the planting of trees and other forms of volunteered public service in forestry.

- Emphasis on management plans that encourage the renovation and enhancement of wetlands to increase their use and value.

- Soil- and water-conservation demonstration programs, in many States, that encourage the use of best management practices and other conservation techniques.

Improving Extension Nutrition, Diet, and Health

The area of nutrition, diet, and health is emphasized in programming through base programs and in a national initiative focusing on food safety. Programs across the Nation encourage dietary practices that contribute to improved health and lifestyle and also provide information on the preservation and handling of food in the home. Other programs focus on food safety education that helps consumers assess risk, promotes cooperation with producers to keep toxic residues at acceptable levels, and contributes to training for food processors and handlers. Still other programs provide information on the specialized dietary needs of infants, youths, expectant mothers, and the elderly. In these programs, CES annually conducts many thousands of educational meetings, answers more than 3 million telephone calls, and reaches 45-50 million persons through the mass media. Some of the efforts within this area are as follows:

- Dietary analyses and health-risk appraisals to encourage dietary practices that reduce cholesterol level and excess weight, provide adequate nutrition, and contribute to improved health and lifestyle.

- Programs that increase consumer confidence in the safety and quality of the food supply, including local food-safety programs through mass media; special forums and training sessions on toxicology and food safety for food processors, food handlers, and representatives of food industry and consumer organizations; and cooperative efforts with producers to reduce risks to food safety during the production process.

- Educational programs and training for food preservers to promote safe practices in home food preservation.

- The nationwide Expanded Food and Nutrition Education Program, which continues to provide nutrition education to low-income households, youths, and expectant mothers with special nutritional needs.

Revitalizing Rural America

Significant efforts were made toward revitalizing rural America through economic development and leadership development for families and local officials while retaining concern for the quality of life. The national initiative Revitalizing Rural America and related high-priority base programs continued to promote economic activity leading to increased employment, income, and public revenue. Other programs supported from public and private funds have trained youths and adults in leadership in communication, issue analysis and resolution, community affairs, and public policy. These programs encompassed the following:

- Integrated educational programs that help communities retain and expand existing businesses and attract new ones. Six communities in one State increased incomes by 12 percent. Other programs helped communities mobilize their existing human resources to take advantage of local natural resources through increased tourism and recreational activities.

- Programs that enable communities to recognize and exploit global markets. Community members receive education in trade and become more aware of knowledge needed for export success. The Rural Information Center plays an important role in making information on opportunities and problem resolution available across the Nation.

- Assistance to existing businesses through market assessments and productivity audits. Firms are assisted in responding to changes in market demand and conditions in the local community.

- Leadership programs throughout the Nation that expose local officials to new ways to deliver services, improve procedures, and expand their communities' potential. These programs assist other agencies in developing team approaches and contribute to the formation of networks for economic and community development.

Developing Human Resources

A broad range of Extension educational programs in FY 1989 continued to focus on the development of human resources, including the well-being of families. Programs in many States assisted families with career planning and financial counseling, and other programs dealt with care of children and communication among family members. Career-counseling programs for youths and job counseling for families were effective in making youths aware of science and technology careers and in helping adult family members make career changes. Leadership development programs increased the capacity of youths and adults to effectively organize and to use the resources available to them as individuals and as members of their communities and States. These programs include

- Financial planning and counseling programs that assist families in budgeting to meet family goals within their current income and to provide for the future. These programs, conducted in most States, have been most effective in assisting low-income families in the management of income and debt. In addition, families at all income levels have been helped with investment and estate planning.

- Cooperative efforts among the Extension 4-H programs and educational institutions that create positive attitudes in high-school youths toward opportunities in science and technology. Family-job-skills workshops mainly in Southern States have brought together employers and job seekers, many from minority groups, to discuss job opportunities and requirements and to facilitate the job-application process.

- Leadership programs for individuals and families that enable youths to develop leadership and communication skills, which expand the range of opportunities available to them. Leadership programs for families have made participants more active and effective in community and public decisionmaking as well as in their private lives. The programs were supported from public and private sources.

Assisting Youth at Risk

The national initiative on Youth At Risk was joined by 41 SCES's during FY 1989, with nearly 700 full-time equivalents of professional staff time assigned to this effort. Four regional workshops were conducted in FY 1989 to develop and deliver education in this area. These educational programs addressed teen pregnancy, substance abuse, dropping out of school, suicide, parent education, and child care. The programs emphasized the development of positive traits in youths and of related skills in parents and community leaders. These efforts receive support from public and private sources. A cross section of these programs includes the following:

- A curriculum of activities and experiences to teach young persons to recognize stress and depression and to take positive steps to protect themselves and their friends. The curriculum is designed for youths 12 to 17 years old and can be used at a variety of meetings and events.

- A PACT (Parents and Adolescents Can Talk) program that enables young people to build positive self-concepts and improve their interpersonal communication and decisionmaking skills. These skills enable youths to exercise greater responsibility over their sexual behavior and to open communication between themselves and their parents. Results show a positive correlation between high self-esteem and a low incidence of sexual activity.

- A pilot program, being developed in West Virginia, that targets potential dropouts and works with them in day-camps and summer schools.

- Programs for 7- to 9-year-olds in which teenagers teach them how to resist drugs and develop communication skills. Interdisciplinary teams are developing a national curriculum to support expansion of these programs.

NATIONAL AGRICULTURAL LIBRARY

The National Agricultural Library (NAL) is the foremost agricultural library in the world with a collection of over 2 million volumes in more than 75 languages and growing at a rate of 32,000 volumes annually. The library also receives 26,000 journals and serials annually, of which 40 percent are in foreign languages. NAL, the Library of Congress, and the National Library of Medicine are the only national libraries of the United States.

NAL is the national source of information on agriculture and related subjects for scientists, researchers, universities, and farmers. It also serves the information needs of USDA employees. The library develops and provides agricultural information products and services in any medium to all who need them. It provides national and international leadership in collecting, maintaining, and making available the agricultural information. In addition, NAL maintains 15 information centers that stay abreast of issues of greatest concern to the agricultural community and provide information on them.

Histories of Alternative Farming Systems Are Recorded

In FY 1989, NAL's Alternative Farming Systems Information Center began videotaping oral interviews with key contributors in the field of alternative agriculture to build a historical record for the future. Two authorities on alternative farming practices recounted their careers and backgrounds on camera. Additional interviews are planned.

Rural Information Center Scores Successes

The Rural Information Center (RIC) provides information to local governments, businesses, rural libraries, community organizations, and other groups working to revitalize rural America. RIC is a joint project of the Extension Service-USDA and NAL. Individuals can access RIC through county and State offices of the Cooperative Extension Service. As of 1989, 49 States and Guam had designated coordinators to work with RIC. One example of RIC's efforts in FY 1989 is that it provided information to a Vermont Extension agent who assisted a handicapped businessman in obtaining a $45,000 Federal small business grant for a wheelchair invention.

Aquaculture Develops Expert System

In late 1988, the Aquaculture Information Center of NAL and the U.N. Food and Agriculture Organization joined in a project to improve access to aquaculture information in Africa. The result is REGIS, a prototype microcomputer system containing the text of "Aquaculture Regional Sector Survey for the African Region" and related documents. REGIS was completed in March 1989 and is available on computer disks through the National Technical Information Service. The REGIS project has been extended into

1990, when updated documents on African aquaculture will be added along with speedier searching capabilities.

NAL Improves Services for USDA Scientists

In FY 1989, NAL continued to work closely with USDA's Agricultural Research Service (ARS) in ensuring that scientists and researchers have access to the most current information. Preparations were made to add the holdings of ARS field libraries to NAL's online catalog, ISIS. During the year, NAL also identified methods to ensure that materials published by ARS scientists are included in NAL's AGRICOLA and ISIS data bases.

Regional Document Delivery Upgrades Operations

Document needs of USDA researchers in 36 States and Puerto Rico are met by the Regional Document Delivery System (RDDS) coordinated by NAL. During FY 1989, NAL worked to improve RDDS. RDDS is a group of land-grant university libraries and local libraries that work together to provide documents needed by agricultural researchers. NAL coordinates these efforts and serves as the library of last resort, providing documents not available elsewhere. RDDS gives USDA researchers access to materials in many collections and expedites document delivery from local sources. In FY 1989, NAL surveyed the services available at land-grant university libraries and provided funds to purchase telefacsimile equipment for five libraries. Urgent requests for materials can now be telefaxed throughout the system or directly to NAL.

State Publications Project Expands

During FY 1989, NAL and 43 State land-grant universities cooperated in recording and announcing the availability of agricultural publications from State experiment stations, State Cooperative Extension Services, and college agricultural departments. In FY 1989, theses from the University of Nevada were added to NAL's AGRICOLA data base, and plans are under way to extend this project to the libraries of the universities of Florida and Nebraska. A comprehensive list of State publications will be published by NAL in FY 1990.

Cooperative Cataloging Effort Grows

Several libraries worked with NAL in FY 1989 to increase their access to agricultural monographs. Texas A&M University, Ohio State University, and the University of Nebraska at Lincoln entered agricultural monograph records into AGRICOLA. Over 200 records were produced through this program during the year. The Ecole des Hautes Etudes Commerciales in Montreal is cooperating in the project as well as the Massachusetts Institute of Technology (MIT). Theses on agriculture published by MIT researchers are being entered into AGRICOLA by NAL. As part of its Text-Digitizing Project, NAL also began adding University of Vermont records on acid rain to AGRICOLA.

Cooperation of University of Illinois and NAL Continues

In FY 1989, the University of Illinois Agricultural Library completed the third year of an agreement with NAL in which the university contributed the records of 50,706 USDA and State agricultural experiments to NAL's data bases. This retrospective cataloging project was made possible by a grant to the university from the U.S. Department of Education.

World List of Agricultural Serials Grows

In cooperation with CAB International, NAL's Cataloging Branch compiled a data base of over 50,000 agricultural serials in FY 1989. NAL has published subsets of this World List of Agricultural Serials (WLAS), including a World List of Poultry Serials. NAL expects to publish the full WLAS data base on CD-ROM in the near future, producing the largest single listing of agricultural periodicals.

List of Indexed Journals Created

NAL's Indexing Branch created a data base containing information on journals that are indexed in AGRICOLA. The data base aids in NAL's publication of the "List of Journals Indexed (LJI) in AGRICOLA," a reference tool for AGRICOLA users. The LJI is produced from the data base and contains nearly 2,000 records. In FY 1989, NAL published the first LJI available since 1983. NAL will now publish the LJI annually.

NAL Creates Data Base for American Floral Endowment

With support from the American Floral Endowment (AFE), NAL's Indexing Branch created a system that provides computer access to information on AFE-sponsored research and education grants since 1961. Information in the data base can be used in the planning of grants to avoid duplication, evaluate past and future areas of industry interests and emphasis, and follow up on work in progress.

NAL Develops Package To Train Catalogers

In January 1989, NAL was awarded 1 of 13 "Apple Library of Tomorrow" grants from Apple Computer, Inc., to develop a computer-assisted instruction package for training novice catalogers. The objectives of this project are to develop an effective alternative to traditional cataloging training, to design and demonstrate the feasibility of computer-assisted instruction for training catalogers, and to develop a cataloger's reference tool consisting of key cataloging-related publications in machine-readable form and linked by hypertext.

Optical Scanning Technology Shows Promise

In FY 1988, NAL started a project to evaluate optical scanning technology for the electronic capture of bibliographic information. The library is comparing this technique with manual data entry. The results of the 1988-89 trials demonstrated that a hand-held scanner is faster but that the number of scanning errors is too high for practical use. NAL will soon begin testing another type of scanner.

AGRICOLA on CD-ROM Is Popular

CD-ROM versions of NAL's AGRICOLA data base continued to be popular with both library staff and end users in FY 1989. The disks provided easy-to-use, controlled-cost access to AGRICOLA for researchers and others, and this access greatly increased the users' awareness of agricultural literature. The AGRICOLA data base is available on CD-ROM from three commercial vendors.

ISIS Makes Headway

In FY 1989, NAL continued to implement ISIS, a computer system used to manage the NAL collection. The library offered public access to ISIS during the year, allowing library patrons to find materials in the NAL collection more easily and quickly through electronic access to bibliographic records. Also during the year, NAL and ARS libraries cooperated in evaluating electronic networking as a means of providing better access to agricultural literature through ISIS. Records from ARS field libraries were loaded into ISIS to permit determination of the benefits of sharing resources. Surveyed NAL staff and ARS librarians liked having access to these records through ISIS. As a result, NAL is developing a program to add access to all ARS library holdings through ISIS.

ISIS aids NAL in managing and controlling the library's collection by providing information on what items are owned and where they are. Telecommunications are in place to accommodate both domestic and international access to ISIS, allowing electronic networking. Access to remote data bases and CD-ROM products using ISIS terminals is also under development by NAL.

Text Digitizing Gains Momentum

The National Agricultural Text Digitizing Project is an effort by NAL and 45 land-grant universities, using optical scanning technology, to capture page images and text in electronic format for dissemination on CD-ROM. The purpose is to provide access to agricultural literature while protecting the original material from deterioration. In FY 1989, over 4,000 pages of text and images of noncopyrighted aquaculture publications were scanned at NAL and distributed on CD-ROM to land-grant universities for evaluation. NAL is also assisting various universities and scientific groups in producing three other disks for evaluation. For each disk, NAL will test and evaluate different search software.

Image Transmission Project Gets Under Way

In FY 1989, NAL began exploring the use of National Science Foundation's telecommunications system (which connects most major U.S. universities) to electronically send digitized page images to libraries. Such a system could provide timely nationwide access to agricultural information. The project involves the transmittal of electronic images and the evaluation of methods of providing document delivery to the end user. NAL will evaluate incorporation of the system into interlibrary loan procedures. The first phase of the project, in cooperation with

North Carolina State University at Raleigh, will be completed in mid-1990.

Electronic Bulletin Board Logs Second Year

NAL's electronic bulletin board, called ALF (Agricultural Library Forum), completed its second year of operation in FY 1989. The system allows access to NAL information to anyone with a computer and communications system for 24 hours a day. More than 7,000 callers used the board in FY 1989, and a toll-free telephone number was added. Additional telephone lines were installed and new computer equipment was added to increase the access and to accommodate the rapid transfer of data between ALF and remote users. Also, ALF computer software was upgraded to improve the features and services offered by ALF.

Video Disk Developed by NAL

NAL, in cooperation with other USDA agencies, developed a 12-inch optical video disk containing nearly 16,000 photographs, slides, and other images on agriculture. The disk is part of a system that improves the access to various collections of agricultural photographs throughout the USDA. The system allows access to visuals by subject, person's name, corporate name, geographic location, and date.

☆ U.S. GOVERNMENT PRINTING OFFICE 1991-521-774/40027 Region 4